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Employees' Welfare in Wartime

Mr. Bevin's recent broadcast aroused such interest amongst employers that it became obvious to the direction of the Industrial Welfare Society that a succinct statement of the fundamentals of the subject was necessary. As a result they have issued a pamphlet,* which is certainly the most intelligently set-out treatise on a matter full of potential pitfalls. The actual duties have been set-out in three numbered paragraphs, but they need to be adjusted, as the pamphlet wisely states, in order to interpret the management's policy, but that policy will be determined by the size, processes, local traditions and circumstances of the firm. The three paragraphs referred to read:—

(1) The recruitment, selection, and allocation to jobs of new workers as these are required; the keeping of employee records; the instruction and training of new workers, and transfer and promotion within the factory.

(2) The supervision of working conditions and arrangements in the factory as they affect health, safety, and well-being of the work-people.

(3) The establishment of close co-operation between employees and management as a means of ventilating suggestions and grievances; and attention to personal problems.

Our experience of shop management would indicate that paragraph (1) should be amended to read "shops" instead of "jobs," the retention of "the keeping of employee records," and the deletion of the remainder.

It is obvious that despite our suggested deletions, there is still plenty of work for a personnel manager in any sizeable establishment. The actual engagement of labour, involving contact with the departmental managers, educational authorities, employment exchanges and the trade unions, together with the introduction of newcomers to works, are to-day time-absorbing duties. In connection with the last, it is essential that the officer in question has full knowledge of the local transport services, availability of lodgings, and local educational facilities. Moreover, the entrant will require to be instructed as to the functioning of the canteens, first-aid room, lavatory and cloak-room, A.R.P., fire and safety regulations. It is also the duty of the personnel manager to keep complete labour records in order that the management may know the exact state of the working force at any given moment, the amount of time lost through absentees of all kinds, and the rate of and reasons for labour turnover. Such records are essential for locating the positions where sickness rate is high, or the reduction of excessive labour turnover by ameliorating working conditions, and so on. Into this last phase there enters all such matters as ventilation, temperature, lighting, nourishment, and medical supervision. Finally there is the important duty of accident prevention. This involves the instruction of new employees in safe working methods, compliance with Home Office Regulations, provision of protective clothing, first-aid boxes, and ambulance services.

A feature of welfare management we should like to see stressed is the absolute restriction of the superintendent's duties to his own particular job and where borderline cases exist we prefer that they should be handled by the shop management. For example, in the case of apprenticeship training, once the directorate is satisfied as to its adequacy it can be profitably divorced from the attentions of the welfare supervisor. Again, the actual operation of safety-first measures is really a matter for the foreman in charge. It is obvious that such processes as the safe stacking of pig-iron, the proper handling of liquid metal, the sanitary operation of shot-blast rooms, the precautions to take in connection with de-enamelling and pickling, all have their technical and practical aspects and are best carried out under the direct control of the shop manager or foreman. We have noticed that where accidents have occurred, those in charge of processes apparently are debited with the lion's share in the apportioning of legal liability.

To our mind the predominant concern of the welfare supervisor should be in the direction of catering for the welfare of the workers when not actually at work. By this we do not mean merely the period which the employee spends within the gates of the works, but externally thereto.

This matter of external welfare is rightly stressed in the pamphlet, and here, especially under present conditions, the welfare supervisor can materially reinforce his internal work by contacting with such organisations as the Y.M.C.A., National Youth Committee, allotment associations, and so forth. If the hobbies of employees can be ascertained, they should certainly be fostered and directed into suitable channels, and the welfare superintendent should take this aspect of external welfare into serious consideration. Several personnel record forms are included in Appendix III, and these have obviously been well thought out. They are equally serviceable for both large and small concerns, and the system disclosed is to be recommended for general application.

* "Elements of Industrial Welfare and Personnel Management." Published by the Industrial Welfare Society, 14 Hobart Place, London, S.W.1. Price 4d. (post free).

Exposure Tests on Nickel and Chromium Electro-Plated Surfaces

Continuing investigations jointly sponsored by the American Electroplaters' Society, the American Society for Testing Materials and the National Bureau of Standards, MR. W. BLUM and MR. P. W. C. STRAUSSER have recently given a Paper in which the results of exposure tests on electro-plated nickel and chromium are summarised. These tests were started in 1936 and 1938, and by co-ordination with earlier ones it is thought that they will apply to more prolonged exposures.

(1) The most important factor in the protective value of nickel-chromium coatings on steel, brass, or zinc is the thickness of the nickel coatings.

(2) On steel or zinc, a layer of copper under the nickel adds little to the protective value of thin coatings. With thick deposits, the protective value of the composite coating approaches, but does not exceed, that of a nickel coating of the same total thickness.

(3) Variations in the methods of preparation and of nickel plating, which included the use of four bright nickel solutions supplied in 1938, had no large effects upon the protective value of the coatings.

(4) Variations in the thickness of the chromium ccating from 0.00001 to 0.00003 in. applied over nickel have very little effect, but if it is 0.00005 in. or more, cracking is likely to occur, especially over nickel coatings on brass.

(5) Variations between basis metals of a given group have no large effects. A greater thickness of nickel is required to furnish a given degree of protection on zinc than on brass, and greater on steel than on zinc.

Catalogues Received

Electric Appliances. Higgs Motors, Limited, of Witton, Birmingham, 6, have prepared and issued three new sections to their general catalogue. Section 9 deals with fractional horse-power motors, 58 with direct-current motors, types W and SW, and section 220 with bench grinders and drilling machines. As they replace obsolete sections, application should be made to Witton for the new pamphlets.

Lamp Fittings. The Midland Electric Manufacturing Company, Limited, have used a folder to announce the introduction of a new range of low-voltage transformer units, under the trade name of "Memlo," and a range of adjustable lamp fittings bearing the name "Memlite." The "Memlo" transformer unit comprises a double-pole switch fuse, a double-wound transformer, and cartridge fuses for the secondary circuit. Low-voltage lighting is a particular advantage in machine inspection pits and other places where danger of shock may exist because of the prevalence of moisture. "Memlite" adjustable lamp fittings are made in eight models, for use on low voltage or direct from mains supply. The range is particularly applicable to foundry conditions, where lighting intensities are usually low. They enable light to be brought right on to the job and are well suited for pattern-makers' benches and similar situations. Another advantage is that the lamps and reflectors are readily accessible for the frequent cleaning which is essential in dust-laden atmospheres. The shades are of spun steel, vitreous enamelled, and are supported independently of the lamp holder.

Some Jobbing Foundry Experiences—II

By "TRAMP"

Fig. 1 is an illustration of a very interesting moulding job occasionally required from country jobbing shops. It is a trough from which pigs are fed. The swill or pigs' food is thrown in through the round funnel A and distributed around the circular pan B, while bars C of wrought iron hold A and B together and also serve to separate the pigs from each other during feeding time. This particular job would doubtless present a few difficulties to the uninitiated, especially when the lack of lifting tackle in these shops is remembered.

The process of manufacture is to procure a sufficient number of bars C of correct length and diameter and then to mould and cast ring A. A joint is made on the outside of the mould along the centre of the bosses D which hold the bars C. These bosses have holes in them equal to the diameter of the bars and deep enough to enable the bars to be securely fastened to the ring during casting. The bars are rammed up in position, and on withdrawing the pattern the ends of the bars C are seen

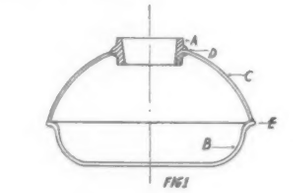


FIG 1

FIG 2

protruding into the mould. These ends have been previously roughened by numerous chisel marks to hold the metal.

This portion of the job is now cast, and the resulting casting appears as Fig. 2. An iron pattern of the pan B has suitable holes in it to receive the ends of the bars C which are now bent over to suit, and placed in position. This will then appear as Fig. 1, where A and C are the ring and bars of the actual casting made during the previous cast and B the iron pattern about to be moulded. Standing in the position shown, the whole of the interior of B and all around the arms C is filled with sand rammed to the correct density for casting. A chain is then passed around A and B to hold them securely together, and the whole is rolled over into a suitably prepared pit in the foundry floor, the joint E coinciding with the floor level. The whole is levelled in position after the removal of the chain. Sand is subsequently rammed around the outside of that already in the pattern and casting, and the pit. Thus the bottom of the mould is prepared and a joint made at floor level.

A top box being placed over the job, guide marks are made for the correct location on assembly. Frequently instead of a mark on the side of the box and the floor, pieces of bar are driven in the ground tight against the box, thus acting as box pins in a two-part moulding box. After the top has been rammed and lifted the pattern is withdrawn and a runner cut into the rim along the joint E and a riser on the top face. The top being returned to position, the job is weighted and cast.

BRITISH TIMKEN, LIMITED, has obtained official sanction for an offer to shareholders of 40,000 new £1 shares at 37s. 6d. The resulting funds will provide part of the purchase price paid for the enemy interest in the Fischer Bearings Company, Limited.

Random Shots

Anyone in Town on business and with half an hour to spare could not do better than to spend it at the National Gallery in viewing the special collection of war pictures. It is a show with a special appeal to foundrymen and engineers of all types, for industry is equally well represented along with actual scenes at the war front. "Marksman," speaking for himself, was struck by the paintings of Raymond McGrath, whose subjects are almost exclusively from aircraft production shops (no official secrets given away). The drawing of his pictures has in every case the precision of an expert piece of draughtsmanship, whilst for delicacy of colour and lightness of effect they seem to be unequalled.

* * *

Gun manufacture and the small arms industry are represented in black and white by Francis Dodd, R.A., whilst of special interest to steelmakers are the works by R. V. Pitchforth, one representing the casting of an ingot (almost all tundish), another called "Sheffield Steelworkers" and a very fine portrait of a very fine Sheffield steel smelter (who looks as if a gallon of beer at one sitting would be a very poor ration).

* * *

A painting by Eric Ravilious entitled "Ship's Screw on Truck" makes the familiar manganese-bronze propeller look a very noble affair, whilst "The Manufacture of Tanks," by Charles Cundall, A.R.A., is a colourful canvas which shows that there is much beauty to be found even in an engineering shop.

* * *

In fact, there is in the whole collection so much unexpected (but nevertheless realistic) colour that it seems quite apt to quote here a little rhyme which has just been sent in.

"Little blobs of cement,
Judicious dabs of paint,
Sometimes make a casting
Look like what it ain't."

* * *

Whilst here in England the activities of the I.B.F. are strictly on a war basis, it is stimulating to read of the many enterprising activities of the A.F.A. still going on in the States. Over there the Branches are known as "Chapters," and amongst the Chapters that of Quad City always seems very prominent. Maybe, though, it is not really more so than any other, but to an Englishman the name stands out more than just "St. Louis" or "Wisconsin." It would be a fine publicity stunt if (after the war) the A.F.A. were to send an invitation to all British foundrymen to "Come and spend a fortnight in Quad!" For the benefit of non-English readers Quad is the place you go to for persistently stealing your mates' tools or for printing false information on the company's balance sheet.

* * *

"Marksman," likes the story of the little American girl who, in telling her father that she had had a lovely dream the previous night, explained that "it was all in Technicolour."

* * *

The chairman of Woolworth's has been appointed to a special position in the Ministry of Aircraft Production, in which he will be concerned (according to the announcement) with "additional fittings to machines after assembly, such as radio, instrument panels, and other accessories." For the benefit of the Air Force boys who will have to use those accessories, it is only fair to say that the "nothing over sixpence" policy of that firm no longer exists!

"MARKSMAN."

Effect of Welding on the Structures of Some Cast and Wrought Steels*

By A. J. SMITH and J. W. BOLTON (Metallurgical Research Department of the Lunkenheimer Company)

Among many welders, aluminium-killed steels are frequently thought of as unweldable. It has been considered difficult and costly to get a radiographically sound weld with such steel. Yet, to the steel foundryman, aluminium is practically indispensable. Getting sound castings is his first objective. Securing sound welds in an aluminium-killed steel is a problem for the welding metallurgist, and it can be done. Attempting to pour castings from semi-killed or rimming steel borders on the ridiculous. A fair degree of success in welding aluminium-killed steels has been attained through use of proper welding rods and proper coatings. It seems only a question of time until proper coatings, rod analyses, and techniques will be developed to make these welds as readily as those in non-aluminium-killed steels.

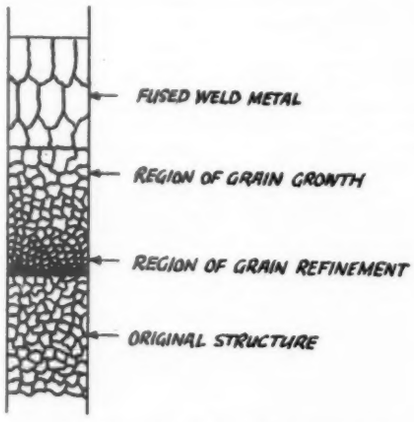


FIG. 1.—SCHEMATIC DIAGRAM OF AFFECTED ZONE IN WELDED MATERIAL.

When necessary, welding stresses often may be kept at small value through corrective design. In other cases, alteration of design cannot be permitted, and relief annealing usually is resorted to. For this same purpose, and also for the elimination of any brittle structures that might be produced, preheating is sometimes used. This use of prior or subsequent heat-treatment leads to a point which appears to have been largely neglected.

Structure of Welds

A section through a weld and the adjacent base metal is shown in Fig. 1. The fused weld-metal and base-metal, which also has been fused, will show the typical columnar crystals growing away from the base metal, the direction in which the heat was abstracted. Below this region will be found coarse grained metal which had been heated to near the melting point and, receding from the weld, the grain size will become progressively finer. Finally, metal is encountered which will have just passed the lower critical temperature and which will be very fine grained. Below this point, the original structure is found, except where slight grain-growth might have taken place.

Impressed on all these structures will be the effect of cooling rate. The cooling rate will be very rapid in the event of a single bead laid in heavy sections without preheat. If, as is customary, a number of beads are laid, the effect will be to draw or temper the structures resulting from the more rapid cooling rate of the first bead. The same result will be arrived at through preheating.

In the work of the Lunkenheimer Company, the severest quenching action has been found right at the weld interface. In some cases, a fully martensitic structure was developed. Such a structure is naturally undesirable and, while the laying of subsequent beads will temper this structure, preheating often must be resorted to in order to prevent cracking. Since it is possible to have martensite developed in a weld, it will be seen that practically all the structures that would be found in a normal heat-treating operation could occur, and, as will be shown later, structures may be found quite different from those usually found.

Test Procedure

In the original work, bars of 2½ in. dia. were butted together and held tightly by means of a screw at the centres. A semi-circular groove was cut in the outside butted edges for arc-welding, and very near the edge of the groove—about ¼ in. away—holes were drilled and thermocouples were inserted in them. Four couples were used in each bar, the couples being placed directly across the groove from one another and in the 0, ¼, ½, and ¾ positions around the bar. A single bead was laid in the groove while the bars were being rotated and, by means of the thermocouples, a complete record of the heating and cooling cycle was taken for each position as welding progressed. The welding was carried out under constant conditions for three-quarters of the way around the bar.

In certain cases, a solid bar was used around which a groove was turned and welding was carried out under exactly the same procedure as in the other tests. Sectional samples were then cut out at the initial and final welding positions, each sample containing the weld-affected portions of both bars and the weld metal joining them. For study of the effect of preheating, electric furnaces were placed around the bars and carefully controlled to give constant temperatures. Preheats up to 315 deg. C were used in these studies.

TABLE I.—*Types and Percentage Compositions of Steels Used in Investigation.*

Steel.	Type.	C.	Si.	Mn.	P.	S.	Mo.	Ni.	Cr.
CC25	Cast	0.23	0.38	0.66	0.028	0.028	—	—	—
CCM25	Cast	0.27	0.40	0.70	0.033	0.029	0.50	0.10	0.03
CCM35	Cast	0.38	0.46	0.66	0.028	0.031	0.48	—	—
CNCM25	Cast	0.26	0.30	0.47	0.029	0.029	0.37	0.87	0.50
WCM15	Rolled	0.19	0.14	0.65	0.010	0.023	0.41	—	—
WCM25	Rolled	0.27	0.20	0.48	0.009	0.048	0.41	—	—
WC40	Rolled	0.41	0.19	0.75	0.013	0.047	—	—	—
*WSS	Rolled	0.12	—	—	—	—	0.24	—	11.74

* Type 416 stainless, not considered a welding grade.

* Abstract of a Paper presented to the Chicago Convention of the American Foundrymen's Association.

Types of Steel Used

In the investigation, five types of cast steel and three types of rolled steel of standard grades were used. The specifications with which they complied are given in Table I. All of them are regularly used for valves, pipe and fittings in high-temperature steam service, and are considered in the trade as of welding grade. A fourth type of rolled steel was also used, a free-cutting stainless, which is not considered of welding grade, but which will be used here to demonstrate points less clearly brought out in the other steels.

Possible Reasons for Grain Coarsening Properties

Table II lists the grain coarsening tendencies of the steels investigated and what appears to be the maximum allowable preheat. From this table, both cast and rolled carbon steels show bad coarsening. In comparison of the two carbon-molybdenum steels CCM25 and WCM25, of much the same composition, while both show coarsening at moderate preheating temperatures, the rolled steel shows worse than the cast and in the lower carbon steel WCM15, the coarsening tendency is worse. The original structures of the three steels are quite similar in size, distribution and general appearance.

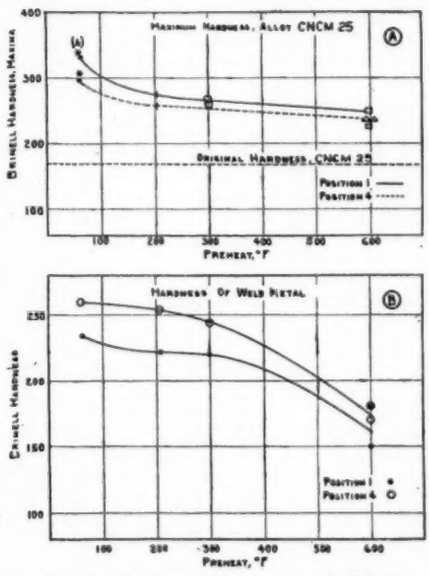


FIG. 2.—HARDNESS OF STEEL CNCM25.

TABLE II.*—*Coarsening Tendencies and Maximum Preheating Temperatures of Steels Investigated.*

Steel.	Coarsening tendency.	Maximum pre-heating temperature. Deg. C.
CC25 ..	Marked	Room temp.
CCM25 ..	Appreciable	93
CCM35 ..	Appreciable	93
CNCM25 ..	Negligible	315
WCM15 ..	Marked	93
WCM25 ..	Marked?	93
WC40 ..	Very bad	Room temp.

* Compare with Table III.

There is, thus, little doubt that the difference of behaviour of the rolled steels is due to the steel manufacturing process, for both have had heat-treatment after rolling. Both showed ferrite banding to a marked degree. The cast steels showed increased coarsening with increasing carbon, and decreased coarsening with increasing alloy content. All cast steels were aluminium killed.

The rolled steels being bought commercially, it was not possible to ascertain their full history. Such rolled steels usually are fully killed also, but the suggestion seems to be that the samples

D

used were not, as there was either little or none of the usual grain refinement due to the action of aluminium. Whatever may be the cause, if these steels are representative of commercial practice (and since they are within commercial specifications, there is no reason to suppose that they are not), greater care must be used in welding and lower limits of preheat must be prescribed for the wrought steels than in cast steels of equivalent analysis, or more adequate specifications should be devised. That other factors may influence this maximum preheating temperature limit is shown in later sections in the Paper.

The effect of preheating on the hardness developed in this alloy and also on the weld-metal applied to it, is shown in Fig. 2. Position 1 in these diagrams refers to the beginning of welding and position 4 to the end. A preheat as low as 93 deg. C. is nearly as effective as a 315 deg. C. preheat in reducing the hardness.

The use of the hardness tester has not, in these tests, proved especially satisfactory in determining whether or not martensite has been formed. It was found that in steels CC25 and WC40 a martensitic or troosto-martensitic structure was developed when welded without preheat. It is evident that erroneous results were obtained in the hardness test and it appears that the cause is not hard to find. The martensitic zone is quite narrow and the diameter of the Brale impression is large in comparison. Thus, not only will hard structure contribute to the hardness reading, but also the softer base-metal and weld-metal back of the hard zone. This assumes that the Brale has not, in the first place, slid off the martensitic ridge into the softer backing material. In either case, a deceptively low hardness reading would result. The hardness of brine-quenched samples of the cast steels ran well in excess of 400 B.H.N. and their structures showed fully martensitic. It is thus felt to be quite evident that the highest actual hardness developed in these welds was not measured, the discrepancy in certain cases amounting to at least as much as 100 B.H.N.

On the basis of microstructure and the hardness readings so far as they can be trusted, Table III has been prepared giving the minimum

Table III.—*Minimum Preheating Temperatures Necessary to Prevent Formation of Hard Structures.*

Steel.	Preheat minimum. Deg. C.
CC25	93
CCM25	93
CCM35	149
CNCM25	149
WCM15	Room temp.
WCM25	93
WC40	149

preheat necessary to prevent the formation of hard structures. From this table, it appears that the hardening of these steels fairly well follows the carbon content. According to the carbon, the steels can be divided into three groups, as follows:—

Group I WCM15—(carbon under 0.20 per cent.).

Group II { CC25—(carbon above 0.22 and below 0.28 per cent.). / CCM25 / CNCM25 / WCM25

Group III { CCM35—(carbon 0.35 per cent. or over). / WC40

It will be seen in Table III that some of the temperatures necessary to avoid development of martensitic structures are higher than the temperature limits fixed in Table II for grain coarsening. Of the two evils, martensitic structure is the worse, and must be prevented at the expense of coarsening.

With this in mind, Table IV has been prepared according to carbon contents and changing the temperature limits according to the need. It should be remembered that these results are derived from data on very severe welding tests, single bead on heavy sections, and hence, in so far as hardening is concerned, are on the safe or conservative side.

Burning-in

The phenomenon of burning-in is clearly brought out in Fig. 3 in which tracings of the macrographs of steel CNCM25 welded to steel WSS with electrode 2* are given, showing the effects of fairly low-temperature preheats. Without preheat, there is a certain amount of lateral melting but penetration into the base-metal is slight. With a preheat of 93 deg. C., a slight amount of melting is shown at position 1, greater in position 4. From the other results where the burning is more uniform, it would appear that the greater burning of steel WSS with this preheat is entirely due to the method of handling the arc during the welding. With a 149 deg. C. preheat, burning is quite uniform all the way around at position 1. In position 4, it is very deep. With the exception of position 4 with

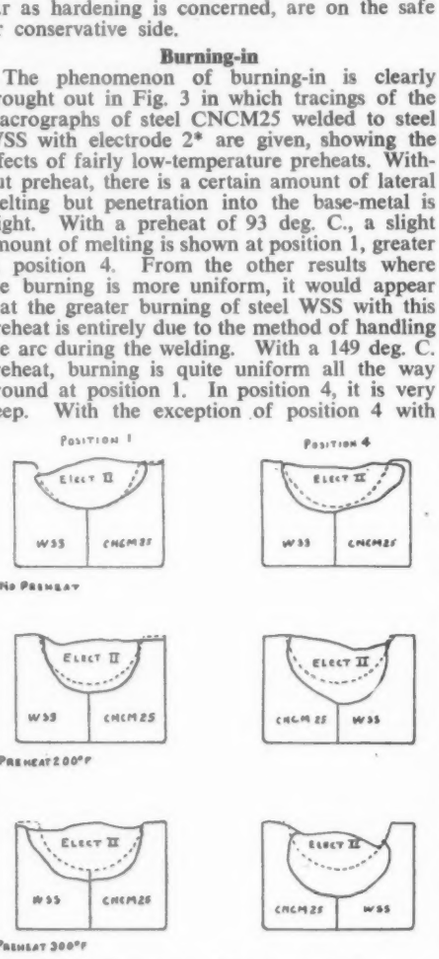


Fig. 3.—Effect of "Burn-in" in Steel CNCM25 Welded to Steel WSS with Different Preheats.

a 93 deg. C. preheat, the penetration was practically the same for both the CNCM25 and the WSS steels.

This penetration in all probability follows only the melting point and is independent of alloy content. The arc temperature is so much above the melting point of the steel, regardless of type, that small variations of the melting point of the two steels to be joined have little effect on the total amount of burn-in. With higher preheats, a greater amount of metal is capable of passing the melting point from heating of the arc.

Table IV.—*Range of Preheating Temperatures to Produce Best Weld Structures.*

Group.	Steel.	Preheat, min. Deg. C.	Preheat, max. Deg. C.	Coarsening tendency.
1	WCM15	Room temp.	149	Marked.
2	CC25	93	204	Marked.
2	CCM25	93	204	Appreciable.
2	CNCM25	149	315	Negligible.
2	WCM25	93	204	Marked ?
3	CCM35	149	204	Appreciable.
3	WC40	149	176	Very bad.

As a result of this melting, great care must be used in the welding of thin-walled material when a preheat becomes necessary. This will be particularly true for fillet and bead welds but, even for butt welds, there may be excessive root penetration and breakdown of side walls. If a strapped butt weld is made, burning through of the strap must be guarded against.

* Coated with mineral and carrying 0.40 per cent. molybdenum in its composition.

Summary

The general principles involved in the alteration of the structure of steel as a consequence of welding have been briefly reviewed, and the structures developed in certain well-known grades of cast steel when welded to common wrought steels have been correlated with these principles. How the structure of a steel is affected by its hardenability and the effects of preheating on the structure have been described.

A trend, in some quarters, to attempt to discredit the safe weldability of steels with carbon contents usually found in casting grades, may have raised questions in the minds of foundrymen and castings users as to the weldability of steel castings in general. From this work, however, it would seem that such discrediting is unwarranted. The structures developed in steels of 0.25 per cent. carbon were fully as good as in the steel of 0.15 per cent. carbon and, so far as granulation was concerned, the wrought steel of 0.15 per cent. carbon was inferior.

The blending of weld-metal and base-metal was exceptionally good in the case of the cast CCM25 and CNCM25 steels. There was little coarsening even at high preheating temperatures and martensitic structures could be prevented without difficulty. With good welding practice, sound, high-strength welds could be made with any of these cast steels, including those up to say 0.35 per cent. carbon.

None of the steels showed a martensitic or near martensitic structure at position 4 (end of weld bead) even with no preheat. The automatic preheating of the preceding weld-metal layer and the conductivity of the base metal prevented formation of a hardened layer. At position 1 (beginning of weld) and no preheat, a definite martensitic condition was found with steels CCM35 and WC40. A very slight layer was found in steel CNCM25 and an approach to a martensitic condition was found in steels CCM25 and WCM25 and also possibly in very small areas in steel CC25. Steel WCM15 showed no evidence of a hard structure in any location.

A preheat of 149 deg. C. would appear to be sufficient to avoid the possibility of martensitic formation on the first part of the first bead in all of the steels examined. Localised heating would probably be sufficient for materials of the class 0.25 to 0.30 per cent. carbon since, once started, the bead "self-draws," as in position 4. Moreover, the laying of a second bead would temper the hard spots in the first part of the first bead.

None of the cast steels showed as marked tendency toward grain-coarsening as did the wrought steels examined. The plain carbon cast steel CC25 was most marked of the cast steels in its coarsening tendency, but, even so, was very much better in this regard than any of the wrought steels. Small amounts of alloying constituents increased the resistance to coarsening, the coarsening tendency in steel CNCM25 being negligible even with high preheating temperatures.

Burning-in of the base metal is less a problem than the foregoing for the foundryman. It should be guarded against, and the influence of design should be carefully considered. Excessive melting or burning-in seemingly is only dependent on melting points and not otherwise on composition of the base-metal. It, of course, is affected by operating conditions of blowpipe or arc and often may be alleviated wholly or in part by suitable manipulation.

In the testing of welds for evaluation of the alterations of structure, it is a conclusion of the authors that, apart from exhaustive tests of

(*Continued on page* 78.)

The Manufacture of a 5-Ton Jet Disperser*

By A. H. MACKAY

The job of making this jet disperser presented difficulties to both the moulding and pattern-making departments. To obtain the development of the contours a full-sized drawing was made of the plan, side elevation and sectional elevation. A number of template lines were projected across the plan and side elevation. The contours were scaled off the blueprint, using the template lines as points from which to work. An equal number of template lines were then marked on the sectional elevation, these being marked to correspond with the lines on the plan and side elevation. By transferring the overall height at each template line on the side elevation to the sectional elevation, and projecting the points of intersection of the templates and contours on the plan to the corresponding template lines on the sectional elevation and joining the points, the curve was developed at each template line.

From these curves the patternmakers were able to make the templates which were called for in the specification. After each curve was laid out on the drawing, tracing paper was used to transfer the curve on to the wood, from which the templates were made.

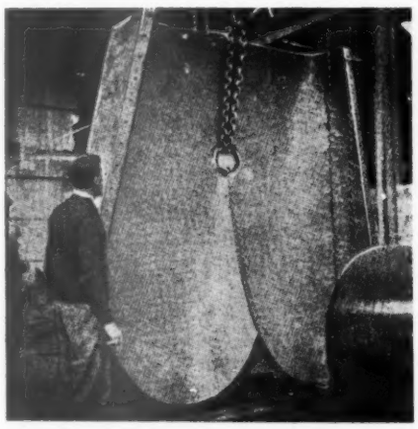


FIG. 1.—FINISHED CASTING.

The two curved ends of the main body were built up in two halves with segments. This was done to accommodate the bobbin, which can only grind to a depth of 9 in. These were afterwards glued together, the inside ribs serving as batons to keep them together. The straight sides were fixed to the curved ends, with ¼-in. plates sunk in flush with the outside of the pattern.

After the main body had been made, and the two longitudinal ribs placed in position, the contour templates were placed along the top ready for checking. This was done by setting a straight edge along the top and the depths of the curves were measured at different points on the template, while they were in position. After this had been done, the templates were screwed down and the pattern finished off ready for the foundry.

Method of Moulding

The mould was made with the curved face uppermost, as this seemed to be the best method of getting a true shape of the curved surface. To facilitate the cleaning and blackening of the mould, the outside was lifted away in the form of a mid, and cores were made to form the flanges on the bottom of the ribs. These were placed in the mould with the pattern, being located by the ribs. They were rammed in as part of the mould.

As the curved face of the pattern was made in the form of a skeleton, the moulder had no difficulty in ramming up the inside. The top surface of the mould was made to conform with the top side of the templates. This formed the shape on to which the top was rammed. After the top was lifted off, the sand was scraped out from between the templates with a strickle, and checked out to give the thickness of metal, giving the true shape of the underside of the mould before drawing the pattern.

By using this method of moulding it was found that the moulder experienced the greatest difficulty in cleaning and blackening the mould, owing to its size and depth of the ribs. The cores in the bottom of the mould became damaged, and needed some hours for patching. Generally, this method of moulding was found to be impracticable, both from the point of view of the time the job was taking to make and of obtaining a satisfactory mould. It therefore became necessary to change the method of moulding so as to make it more convenient to clean and blacken.

In deciding on a more convenient method of moulding consideration had to be given to the extra cost entailed for altering the pattern and for new tackle, if it should be necessary. With this end in view it was decided that the easiest way out of the difficulty was to make the inside of the mould in cores. To do this a core iron was made for each of the fifteen cores, formed by the ribs on the underside of the mould.

The pattern was placed on a flat bed and the shape of the mould marked off to give the position of the core iron. The pattern was then lifted off and the core iron placed in position, after which the pattern was replaced and the mould rammed up, as in the first method, using core sand for the inside portion, which was being made in cores.

After the pattern was drawn these cores were lifted out and blackened and dried separately; this presented no difficulties whatsoever. It was not necessary to lift the outside away, and only a plain mould was left when the inside cores were removed, the moulder being able to get inside to blacken it.

To avoid having to level a new flat bed for each mould, two rails were bedded in parallel to each other, these being left in when stripping the casting, thus giving a guide for striking the new bed for each mould. As the order was for eight castings, by changing over to this method of moulding a total of at least 150 hrs. was saved in the moulding time and a much cleaner and more satisfactory casting resulted. The only extra cost incurred by the change was the making of the core irons. No alteration was necessary on the pattern. It will be seen that the cost of making these core irons was fully justified.

The casting weighed approximately 5 tons, and was poured from both ends with a 2-ton ladle and a 3½-ton ladle. This was necessary owing to the long distance the metal had to travel in the mould; the overall size of the job was roughly 10 ft. long, 9 ft. wide and 22 in. deep.

Moulding Tackle

The tackle was made to suit the method of moulding decided on in the first instance. The mid, or moulding box to carry the outside of the mould, consisted of four plates cast separately and bolted together through cored holes. The two inside or end plates were flanged at each end for bolting on the sides. The four plates had holes cast in them through which the grids for carrying the outside shape of the mould were attached.

The top box or cope was made flat and in two halves, bolted together in the middle with 1-in. fitted bolts. This was done both for convenience in moulding and casting, and also for adaptability to general foundry use when the job was completed. The deep lift in the top was overcome by using the first casting as a core bed, the curved surface being filled with sand and a grid being cast on it to follow the shape of the casting. This grid was bolted to the top box, thus obviating the necessity for the hooks which were used on the first mould.

To draw the pattern, two mild-steel frames were made to stand on the two outside edges of the moulding box, with draw bolts placed in position to coincide with the draw plates on the patterns. The pattern was drawn by screwing the nuts on the draw bolts which were threaded long enough to lift the pattern clear of the mould. By this means the pattern was drawn with very little of the mould breaking away.

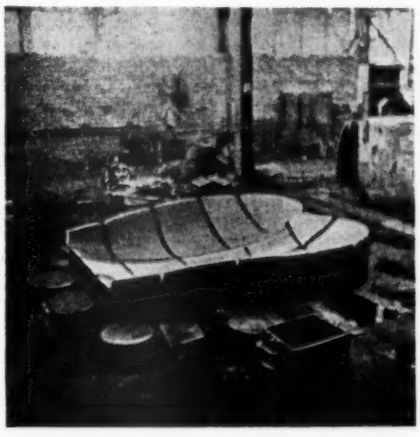


FIG. 2.—VIEW SHOWING THE METHOD OF MOULDING.

This description of two methods of moulding the same casting with practically the same moulding tackle shows how much easier the job was made by the second method. It will serve to illustrate the importance of studying each job carefully before starting to make patterns and tackle. Naturally, close co-operation between the foundry and patternshop is called for. This is by no means an isolated case in the author's foundry or any foundry along the Reef. There have been numerous personal experiences where moulders have been blamed for taking longer on jobs than the time estimated by the foreman moulder, whereas if the moulding method or tackle was altered to suit the job, hours would thereby be saved.

A jobbing foundry has very often to use makeshifts where only one casting is required, but this practice has probably been abused to such an extent that foundries are expected to make large quantities of castings from tackle which is not suited for the job. Everybody is happy to carry on with this makeshift method until something goes wrong—a top falls out, which means, in most cases, the mould has to be made over again. The result is that the

(*Continued on page* 76.)

* Paper presented before a meeting of the South African Branch of the Institute of British Foundrymen.

Tentative Recommended Practices for Sand-Cast Foundry Bronzes, Red and Semi-Red Brasses

GENERAL RECOMMENDATIONS

Moulding

Sands.—Sands used in making castings of these alloys should be selected to give the required casting surface smoothness, a characteristic dependent to a great extent on the grain fineness. At the same time, they should have sufficient strength to hold the mould intact during moulding and pouring. The sand must also have sufficient permeability to carry off the gases produced in pouring rapidly enough to prevent defects. For some work, the mould surface may be sprayed with molasses water, with or without drying, to increase its strength.

The sands used should provide the following physical properties (sands approaching the minimum limits should prove best for light work, while those near the maximum limit will be suitable for heavy work):

	Min.	Max.
Compressive Strength, lbs. per sq. in.	5	7
Permeability (A.F.A.)	12	24
Clay Content, per cent.	10	20
Fineness Number (A.F.A.)	140	230

Facing.—It is not common practice to use facing sands for these alloys except in special cases. If the moulding sand used meets the above specifications, it should be fine enough to impart a satisfactory smoothness to the casting. When a facing is required on the mould surface, materials such as flour and plumbago are sometimes used; the former for small castings and the latter for large castings. For castings produced from metal containing appreciable amounts of phosphorus, a plumbago coating frequently is employed.

Gating and Heading.—Gating and heading of castings made of these alloys is very important. A study of each particular class of castings should be made before deciding what type of gate is to be used. Castings such as heavy flanged valve bodies must generally be provided with risers to feed the flanges. While the use of risers or feed heads can be very beneficial if properly applied, they can introduce certain difficulties if not sufficiently large. In such a case, the risers may solidify before the casting and draw metal from the casting, thereby increasing unsoundness rather than reducing it.

Wherever possible, risers should be so placed that they will fill with as hot metal as possible to ensure that they will remain liquid until the casting has set. This is usually accomplished by arranging the gates and risers so that the metal flows through the riser to the casting. In large work, where open risers are used, they can be fed with hot metal after the sprue is full. The sprue should be sufficiently larger than the gates and runners to ensure that they will be kept full during pouring. The use of skim gates or strainer cores also will prove beneficial in preventing foreign material from entering the mould. They also tend to produce a more even flow of metal into the mould.

For castings such as index plates and other castings of light uniform sections, where rapid pouring is necessary to run them, a choke gate is recommended. For castings of very non-uniform section requiring rapid pouring, the use of choke gates and risers, set on heavy parts to take care of the shrinkage, is suggested. Castings of the small uniform variety may best be gated by a simple brass or bronze type gate.

Cores.—Fine silica sand and a good grade of core oil are suggested for cores that can be laid flat or where driers are available. If it is desirable to stand cores without shells, a cereal binder can be added to produce the desired green strength, or a fine floor sand containing 1 to 3 per cent. clay, mixed in various proportions to produce the necessary green strength, can be used. A mixture of 50 per cent. silica sand and 50 per cent. floor sand often is used for cores requiring a smooth surface. Care must be taken not to leave cores containing cereal binder in the mould too long before pouring, as they absorb moisture rapidly and might cause blowing. Coating the cores by dipping, spraying, or brushing with graphite, or some other suitable core wash, will reduce the burning-in of metal and help in making castings smoother on the cored surfaces. It is important to have strong, well-vented cores, as many of the castings in which these alloys are used are intricate and have thin walls so that much pressure is placed on the core when the metal is being poured. However, cores must not be too hard, otherwise they may cause casting cracks and difficulty in core knock-outs.

This Report is the sixth in the series of recommended practices being sponsored by the Non-Ferrous Division of the American Foundrymen's Association. Further information on various groups of alloys can be found in the Cast Metals Handbook (A.F.A., 1940), Non-Ferrous Section.

Although the various practices herein are recommended by those considered specialists in the various fields, they are not intended as specifications. Wherever possible, the alloys referred to are identified with existing alloy specifications.

The publishing of data relative to various alloys and treatment of such alloys by the American Foundrymen's Association does not insure anyone using such data against liability for infringement of any patents that may now exist or are pending. It also should be understood that the publication of data concerning patented alloys or processes does not constitute a recommendation of any patent or proprietary right that is involved.

In preparing these recommendations, the Division has attempted to collect, through reliable sources, such information as will be of practical use to foundrymen handling non-ferrous alloys.

This Report, which has been slightly abridged, is limited to sand-cast foundry bronzes, red brasses and semi-red brasses.

Melting and Pouring

General.—The production of high-quality castings cannot be accredited to any one type of melting equipment as there is ample proof that high-quality castings are being produced from all the types of non-ferrous melting equipment in use to-day. The ideal or foolproof melting furnace is yet to be designed; therefore, the following information is intended to help the foundryman to avoid melting practices that might tend to produce sub-quality castings.

In general, metal should be melted as rapidly as possible and not held in the furnace after attaining the desired temperature because the absorption of gas by the metal and oxidation of metal are both a function of time and temperature; that is, as the temperature increases the rate of gas pick-up or oxidation increase, or if the metal is held at a fixed temperature the gas pick-up or oxidation will increase with time. The harmful effects of excessive gas absorption may be corrected, at least partially, by allowing the metal to solidify and remelting under proper furnace conditions, as the gas absorbed during melting tends to be liberated upon solidification of the metal. A slightly oxidising flame or furnace atmosphere is considered desirable for best results. There are at least two possible reasons for this: (1) The slight oxidation has some refining action, and (2) it is believed that the gases present in an oxidising flame or atmosphere are either less soluble in the metal or more readily removed than those of a reducing atmosphere.

Types of Melting Equipment

Crucible.—Although crucible melting is one of the oldest methods of melting, the bulk of the alloys covered in this Report are still melted in crucible furnaces of the stationary or tilting types. There is a tendency to abandon solid-fuel furnaces using coal or coke, in favour of those using oil and gas. The use of oil and gas facilitates faster melting and better control over melting conditions. When using natural draft, the use of a charcoal covering to reduce oxidation is recommended, preferably put in the bottom of the crucible before the metal is charged. It has been indicated that charcoal, unless thoroughly dry, may be a source of gassed metal; therefore, care should be taken to have the charcoal dry before using.

If the metal used is rather dirty or a large percentage of borings is used, a flux of the glass type will prove helpful in collecting the drosses. A mixture of 50 per cent. glass and 50 per cent. borax works quite well for this purpose. Care must be taken not to use a flux that will attack the crucible, as this may result in the metal picking up undesirable impurities, or materially reducing crucible life. If, when using forced draft, it is found difficult to keep the charcoal in the crucible, a glass covering can be used.

When firing with oil or gas, the flame should be kept slightly on the oxidising side. Due to the high velocity of the flame when using these fuels, it is difficult to keep a charcoal covering on the metal; therefore, the glass type of cover is recommended, although, if the flame is properly controlled and holding of the metal is avoided, the necessity for a covering is reduced to a minimum.

If these metals are alloyed in the foundry, the copper is first melted and heated to approximately 1,050 deg. C. The necessary alloying elements are then added in the form of commercially pure metals. The order of adding the alloying elements is usually—tin, nickel, lead, zinc and finally phosphorus. The alloying additions should be made gradually and in pieces of such size and shape that rapid solution takes place and the molten metal will not freeze. The metal should be stirred thoroughly after the alloying elements are completely melted.

It is possible to obtain these alloys covered in these practices in the form of ingots having the required chemical composition. The use of such ingots simplifies the melting procedure and eliminates irregularities in alloying practice and the necessity for violent stirring prior to pouring. If a certain percentage of foundry scrap is used in the melt, this material should be charged into the crucible first, to provide a bath of molten metal for the copper or alloy ingot. This procedure will shorten the melting time because pure copper, by itself, melts at a somewhat higher temperature. Copper in ingot form and alloy ingots will melt somewhat more slowly

by reason of their size. Zinc should be added for that burned out during melting, in accordance with individual furnace practice in each instance.

Open-Flame Furnaces.—In an open-flame furnace, where the flame is in direct contact with the metal, a proper melting zone is important. Proper combustion, to prevent the absorption of gases or impurities is essential. The furnace should be preheated thoroughly before the metal is charged, after which the metal must be melted rapidly and not overheated if maximum physical properties are expected. A few minutes before tapping, low melting-point metals are added and thoroughly mixed in the bath of metal. To ensure proper conditions throughout the melting period, the flame should be kept slightly on the oxidising side and careful maintenance of the melting zone and the burners, which regulate the combustion, is necessary.

Electric-Arc Furnace.—In the electric-arc furnace, the normal atmosphere is neutral or slightly reducing. Under these conditions, little or no refining action takes place, so care must be taken not to charge metal that contains impurities that might normally be burned out in the crucible or open-flame furnaces, into the electric-arc furnaces. Some foundries have developed methods of removing impurities by the introduction of various chemicals during melting.

Materials containing oil or other organic matter should not be charged into the furnace as they break down to form a finely divided carbon or soot, the presence of which almost invariably results in the metal having a very porous crystalline structure. This effect seems to be more pronounced as the lead content of the alloys increases. Improper adjustment of the arc at times will produce soot, with the same result upon the metal. The constituents of the alloy to be melted can all be placed into the furnace at the beginning of the heat, whether it be ingot or metal alloyed from the individual metals. Fluxes of the glass type or charcoal are not used in this type of furnace under normal conditions.

Deoxidising

Deoxidation is the process by which the foundryman attempts to remove the oxides dissolved by the metal during melting. Such oxides, if not removed, may appear in the casting as dross. Phosphorus, due to its strong tendency to combine with oxygen, takes the latter away from the molten metal and forms an oxide of phosphorus; this, being a thin slag, is easily skimmed from the top of the ladle or crucible. For deoxidation purposes, an alloy of copper containing 10 per cent. to 15 per cent. phosphorus is most generally used. The amount necessary to accomplish deoxidation will depend upon the amount of oxygen the metal has absorbed. Under normal conditions, 1 oz. of 15 per cent. phosphor-copper per 100 lbs. of metal will be sufficient.

An excess of phosphorus should be avoided as it has a very marked effect on the fluidity, increasing the ability of the metal to penetrate any cores present. Phosphorus also has a tendency to produce dirty castings by attacking the moulding sand and by accelerating the formation of excessive zinc oxide. Additions of deoxidisers are best made to the ladle or crucible after any slag or dross has been skimmed off, and then the metal should be stirred well.

Melting and Pouring Range

It has been estimated that a major percentage of the castings scrapped are those which have been poured at improper temperatures. The use of a suitable pyrometer is the only means of controlling pouring temperatures with sufficient accuracy. The pyrometers used for the alloys discussed in these practices are of the immersion type using chromel-alumel thermocouples. Two types of thermocouples are available: (1) Those using metallic protecting tubes so that the thermocouple does not come into contact with slag or dross and thus give an erroneous reading; this type will give more reliable results with inexperienced operators, and is recommended. (2) The open-end couple, or those without protecting tubes.

The second type of couple is four times as fast as the other type and, in the hands of an experienced operator, is just as accurate. One method of manipulating this second type of couple is to immerse it in the metal about 6 in. until the meter comes to rest, then raise it rather rapidly until the end of the couple is within an inch of the top of the metal, and take the reading at that point. Agitation of the couple during the reading will help to prevent slag or dross from bridging between the wires and giving a false reading.

It is usual practice to remove the metal from the furnace somewhat above the desired pouring temperature, possibly 25 deg. C. The ladle or crucible is then skimmed free of slag or dross, the deoxidising agent added and the metal stirred. The metal then can be cooled to the desired temperature and poured. The present opinion in regard to pouring temperature of these alloys is to pour closer to the high limit rather than the low limit of the range that gives these conditions. Pouring temperatures between 1,070 and 1,260 deg. C. normally are used for these alloys, depending upon the size and shape of the castings and the type of gating used.

Finishing

Gates and risers usually are removed from small castings by sprue cutters; on larger castings, by band saws. Some foundrymen break the casting off while hot, but this method is not recommended as the hot-shortness of these alloys causes considerable scrap due to the fact that the casting often does not break off in the right place. The remaining flash or fins are removed by grinding. Small castings usually are cleaned by barrel blasting, while the larger ones are blasted on a table or in a room.

Heat-Treatment

There is no supporting evidence to indicate that the physical properties of these alloys can be improved by any of the usual methods of heat-treatment.

Defects, Their Cause and Prevention

Shift.—A casting in which the cope and drag portions do not exactly match at the parting line. *Cause.*—Flask pins or pattern equipment inaccurate.

Misrun.—A casting which lacks completeness due to the fact that the mould cavity has not been wholly filled with metal. There may be a smoothly rounded hole through the wall of the casting, or one or more extremities may be only partially filled out. *Causes.*—Insufficient pressure, sprue not high enough. Gates too small. Sand too wet, causing metal to chill. Sluggish metal (check impurities and melting practice). Metal too cold. Interruption during pouring. Sand too close (increase permeability).

Cold Shut.—The casting appears to be cracked, but on closer examination it is found that the metal has failed to join or coalesce along the line of the apparent crack. In some cases, partial coalescence leaves a line of weakness which later does crack. *Causes.*—Similar to those indicated for "Misrun."

Crush.—A casting showing deformation, apparently due to displacement of sand when the mould was closed. *Causes.*—Core prints and cores not matching. Warped bottom boards or flasks. Weights too heavy or handled too roughly. Low-strength sand. Careless moulding.

Swell or Strain.—A casting showing deformation on cope side due to displacement of sand by pressure of metal. *Causes.*—Insufficient weighting or soft ramming.

Variation in Wall Thickness.—A casting which at one or more points shows more or less metal than is called for by specification. It may be uniformly too heavy, uniformly too light, or may be too thick on one side of a cored cavity, too thin on the other. *Causes.*—Worn pattern or core equipment. In some cases, where long thin cores are used, cores may warp or "float." Stiffer core wire required. Uneven ramming of sand.

Sand Wash.—The casting may have rough lumps of metal at some points on its surface or may exhibit rounded corners which should be sharply defined. At other points, there will be roughly granular depressions or holes. *Causes.*—Core prints oversize. Too light ramming. Sand weak. Sand too dry. Weak cores.

Scab.—A rough spot sometimes loosely adhering, usually on a thin-walled portion of the casting, the wall being slightly thicker than normal at this point, porous and containing sand grains. *Causes.*—Sand rammed too hard or sand too brittle.

Sand Blow.—The casting shows an unnaturally smooth depression at one or more points on its outer surface. *Causes.*—Sand too low in permeability or too wet. Insufficient venting.

Core Blow.—The casting shows a smooth depression, sometimes black, sometimes golden, on an inner surface where there is a cored cavity or often a gas pocket in some heavy portion of the casting above the level of the cored cavity. *Causes.*—Insufficiently baked or improperly vented cores; also from non-dried pasted cores.

Burning into Sand.—Certain outer parts of the casting have a rough sand appearance as if the metal had penetrated freely between the sand grains, some of which are completely surrounded and enclosed in the outer wall of the casting. *Causes.*—Sand too coarse or open. Metal too hot or fluid from excessive phosphorus.

Burning into Cores.—Sometimes a rough, sandy inner surface, similar to the penetration of metal into green sand, but more commonly in the form of metal fins penetrating into the core and containing trapped grains of core sand. *Causes.*—Metal too hot or fluid. Core sand too coarse or improperly coated. Cores weak, soft, or friable.

Sand Sticking in Cored Cavities.—Even when there is no apparent "burning in," castings having intricate cored passages, or cavities of small dimensions and relatively inaccessible, sometimes show a tightly adherent coating of sand. *Causes.*—Cores too hard or metal burning into core.

Surface Imperfections.—Castings, otherwise of apparently perfect quality, sometimes have surface defects which may be of importance on the ground of appearance only. In other cases, these apparently superficial defects are indicative of deeper-seated ailments. The following items are listed as typical:

Wormy Surface.—The surface of the casting, usually in the vicinity of the gate, shows irregular depressions, shallow but elongated, similar in appearance to worm track. These depressions are often filled with a deposit of zinc oxide, and are sometimes accompanied by a very poor fracture. Sometimes called "zinc worm." *Causes.*—"Wormy" surface, near the gate, is sometimes due to inadequate gating (especially with heavy sections which require a long time to fill the mould cavity). In leaded alloys, very small percentages of silicon or magnesium (0.03 per cent.) are likely to produce a "wormy" surface. Silicon may be picked up

from silicon carbide in a furnace lining or, in the indirect-arc furnace, may be caused by the action of oil, electrode smoke or other carbonaceous material.

Surface Stains.—The surface of the casting shows a black discolouration of varying size and shape. *Causes.*—Surface stains are sometimes due to the excessive use of flour or molasses.

Tin or Lead Sweat.—The surface of the casting is more or less covered with a thin layer of white metal. In the case of lead, the sweat often occurs in spots or lumps, sometimes of considerable thickness. *Causes.*—Contamination by silicon also tends to produce lead sweat. Silicon may have been present in scrap used in the furnace charge, may be picked up from silicon carbide in a furnace lining or, in the electric furnace, may be produced by the action of oil, electrode smoke or other carbonaceous material. Excess phosphorus with the higher tin contents may produce sweat.

Rough or Pitted Surface.—Although the casting does not show evidence of sand washing or scabbing, the surface is rough or exhibits an occasional angular pit, sometimes pin holes, which are often so deep as to leave an objectionable scar on a finish-machined surface. *Causes.*—Coarse sand or dirty sand, which contains fragments of cores or metal, will cause the surface of the casting to be rough or pitted. Very fluid fluxes that cannot be readily skimmed from the surface of the metal are likely to be carried into the mould, resulting in surface imperfections on the casting. Faulty skimming or careless pouring may result in fragments of slag or oxidised metal entering the mould and lodging on the surface of the casting.

Solid Inclusions.—With a fracture which otherwise appears to be good, the walls of the casting contain particles or small chunks of non-metallic substance, or separate pieces of metal not coalesced with the body of the casting. The latter is often referred to as a "cold shot." *Causes.*—Oxidised metal or slag being carried into the mould cavity with the metal. Aluminium contamination. Pellets of metal from a splash ahead of the main stream.

Shrinkage Cracks and Cavities.—With a fracture otherwise apparently good, the casting shows at one or more points a crack or cavity where the metal has pulled apart while it was still in a plastic condition. The walls of the shrinkage cavity are usually tarnished to a colour which varies from orange to dark brown. *Causes.*—Shrinkage cracks may frequently be due to improper gating or to the lack of risers where needed. Pouring temperature too low. Poor casting design, lack of fillets, etc.

Weak or Discontinuous Structure.—The fracture of the casting is bad at practically all points. Commonly, the structure is dendritic with minute fissures between the large crystals, which are tarnished to an orange or brown colour. Sometimes with crystals of more normal size, the fracture is of a loosely granular appearance rather than fibrous. Other varieties of abnormal fracture may be encountered. *Causes.*—A coarse, dendritic, discoloured fracture is most commonly due to the presence of silicon, magnesium, or aluminium in the alloy. Too high a pouring temperature will result in a coarse, weak crystalline structure.

Gas Porosity.—This condition, sometimes called sponginess, is marked by small but clearly discernible gas bubbles caused by evolution of gas from the molten metal when solidifying, usually segregated near the surface but underneath the skin of heavy sections of the casting. The cavities are approximately round and bright, free from tarnish *Causes.*—Gas porosity most frequently results from the presence of gases, absorbed from the furnace atmosphere during melting and not removed before pouring. Metal pouring temperature too high. Excessive phosphorus. Using insufficiently dried ladles or furnace linings.

Cleaning Defects.—All cleaning defects are caused by careless handling of the cleaning equipment, fracturing gates and risers into castings themselves, or from insufficient knowledge of the size and shape of the casting.

Defects Caused by Impurities in Metal

Phosphorus.—Phosphorus is usually employed as a deoxidiser. For this purpose, not more than a trace need be retained in the final alloy. Appreciable amounts lengthen the freezing range of these alloys and increase their fluidity to a marked degree. Phosphorus increases the hardness and, in some cases, has a tendency to discolour the surface of the casting. It also increases the tendency of the castings to show "burning-in" and consequent rough appearance.

Silicon.—Silicon also is a dangerous impurity. As much as 0.05 per cent. is likely to produce decided unsoundness. It apparently goes into solid solution and affects the crystallisation characteristics of the alloy. In leaded alloys, the tendency towards formation of dross is pronounced. The casting usually presents a worm-eaten, whitewashed appearance on the unmachined surface.

Aluminium.—Aluminium is an extremely dangerous impurity, and even a few hundredths of 1 per cent. is likely to ruin the alloy, because it makes the castings very unsound. Aluminium apparently alters the crystallisation characteristics of the alloy markedly. Even very small amounts sometimes cause lead sweats. In pressure work, leakers often are due to oxide inclusions.

Antimony.—Antimony, up to 0.25 per cent., does not cause trouble.

Iron.—Free iron, even in small amounts, causes hard spots. Alloyed iron, within the specification, has no effect on these alloys. High iron increases the hardness materially, particularly when not in combination or when nickel is present.

Sulphur.—Sulphur, in amounts up to 0.05 per cent., will not cause trouble. Sulphur seems to promote sulphide inclusions, which, if not too great in amount, do not seriously impair the properties of these alloys.

Magnesium.—Magnesium affects these alloys in much the same manner as silicon, and even traces should be avoided.

The alloys referred to in this Report are of the following types:—

Foundry Bronze.—Cu 85; Sn 5.0; Pb 5.0; Zn 5.0; Ni 1.0 (max.), and P 0.05 (max.) per cent.

Red Brass.—There are two varieties dealt with in the Report, ranging from 77 to 83 copper; 4 to 5 tin; 6 to 10 lead; 5 to 7 zinc, and 0 to 2 per cent. nickel.

Semi-Red Brasses.—In this case three are considered, the compositions of which fall into the following range:—Copper 77 to 80; tin 2 to 3; lead 7 to 10; zinc 9.5 to 13, and nickel 1 per cent.

Generally speaking, for all of these alloys it is recommended that the phosphorus content should not exceed 0.05 per cent., the antimony 0.25, the iron 0.25, aluminium should be completely absent, the silicon 0.005, and the sulphur 0.05 per cent. Moreover, the total impurities (other than nickel) should not exceed for foundry bronzes and red brasses 0.5 per cent.

Electric Smelting of Swiss Ores

Discussing the potentialities of smelting Swiss iron ores, G. KELLER, in the "Bulletin des schweiz. electrotechn. Vereins," states that two units each of 10,000 kw. would be required, and even if operated continuously throughout the year, would be barely sufficient to cover Swiss requirements. The total annual iron and steel requirements of Switzerland are 70,000 tons of pig-iron and 300,000 tons of semi-finished and finished steel products.

The Manufacture of a 5-Ton Jet Disperser

(*Continued from page* 73.)

mould has taken much longer to make and everyone wonders why.

DISCUSSION

MR. H. J. BRAGG inquired if the cold shut could have been obviated if risers had been used at the point where it occurred.

MR. MACKAY replied that he had reached the conclusion that the cold shut was due to cold metal.

MR. H. HOLDSWORTH suggested that possibly in starting on the pattern there might have been a golden opportunity to follow out Colonel Grose's idea of plywood, which would have simplified some of the curves. A second point was in regard to melting. The proper way to avoid cold shuts was to ensure hot metal, though he realised the difficulties when the tackle was not appropriate.

MR. MACKAY explained that the metal was brought down in cupolas averaging about four tons an hour. A mechanical crane was used. When one ladle was being filled the other was taken on to the job. Some time was wasted in transferring the ladles from the crane, and consequently the metal was not very hot when poured. He considered that plywood would have been useless because it would not bend on a double curve, and the ramming in of sand could not be achieved with plywood.

Possibility of Using Plywood

MR. FRASER asked if there was a method of bending plywood into a dome shape, but the question remained unanswered.

MR. HOLDSWORTH agreed that the plywood pattern system applied to simple curves. However, he thought it would have been possible to bring three-ply to half-way, thus saving time.

MR. MACKAY thought Mr. Holdsworth would appreciate that if the surface had been closed up, the moulder would have been unable to ram inside, and that was the reason why the top was left open.

MR. HOLDSWORTH agreed that the old-fashioned method of using a solid top and ramming from underneath was most difficult.

In reply to a suggestion that narrow strips about 1½ ins. wide might have been used, MR. MACKAY agreed that they could have been used, but pointed out that the time required would be considerable, while the method of leaving the top side open offered many advantages. To spokeshave and curve a pattern which measured 9 ft. by 10 ft. and which was 3 ft. deep at its deepest point, was unthinkable. As it was, each template had to be spokeshaved when put in position. It took 210 hours to make the pattern. The moulding time was roughly 160 hours for the first casting and 120 hours for each subsequent casting. One of the reasons for the time taken was the short period of delivery. Four men working on the same job did not do four times as much as one man. Also, a night shift had to be run.

In thanking Mr. Mackay on behalf of the Institute, DR. H. J. VAN ECK (chairman) said that the author had given a complete description of the job through the whole of its phases. Such descriptions were of very great interest. It was desirable to deal with practical moulding and the problems involved in jobs actually undertaken in foundries. More Papers of a similar nature were required.

Control of Pyrites

The Control of Pyrites (No. 1) Order makes the Minister of Supply the sole purchaser of pyrites produced in the United Kingdom.

Any communication on this subject should be addressed to the Controller of Sulphuric Acid, Ministry of Supply, 19, Berkeley Square, Bristol, 8.

Slag Control in Steel Furnaces

HOWE MEMORIAL LECTURE

The Henry Marion Howe Memorial Lecture to the American Institute of Mining and Metallurgical Engineers was this year delivered by Dr. C. H. Herty, who dealt with the subject of "Slag Control." The lecture has been published as Technical Publication No. 1,203 in "Metals Technology," from which the following extracts are taken.

Introducing his Paper the author states that in the present era of close specification, the drive for uniformity of product, and the close inspection of the product and of the cost sheet, the utmost efforts must be made to control the steelmaking variables to the best advantage of the steel producer. One of the major variables is the slag in the furnace and its effect upon the composition and quality of the metal.

The elimination of undesirable constituents such as phosphorus and sulphur is entirely a matter of slag composition and physical nature, a point well known for over half a century. The role played by the slag in assisting in proper heat transfer from roof and flame to the steel has been equally well known. In more recent years there has come the problem of oxygen control in the more accurate gauging of additions for making high-grade rimmed steel for the new strip mills, and in the deoxidising additions for grain-size control and cleanliness of forging steels, both carbon and alloy. In this problem the oxidising characteristics of the slag are of prime importance.

In considering any method of control it is necessary to view critically the costs involved, and balance these against the gains. The costs will include the equipment and the personnel necessary, and any adverse effect of the method on operations. The effort required on the part of the operating staff must also be considered. The gains to be derived may include a decrease in avoidable losses, increase in output, a higher quality, or a more uniform quality. The control method may also provide a better chance to solve questions arising from too great a number of variables operating simultaneously.

Slag Reactions

Early in the study of slags, rapid strides were made in determining the constituents of the slag that affected the elimination of metalloids, particularly phosphorus and sulphur. The Journal of the British Iron and Steel Institute contains a number of articles indicative of the thought that was being put upon the problem of slag-metal reactions in the nineteenth century. As early as 1879 Snelus gave a complete exposition of the use of lime in the elimination of sulphur and in 1885 Vogt found that sulphur was present in the slag as calcium sulphide. Jüptner summarised the reactions controlling sulphur in a most complete manner. It was shown by Osann that high lime and low oxide were essential for extensive sulphur removal. He wrote the reaction for sulphur elimination as

$$FeS + CaO \rightleftharpoons CaS + FeO$$

the form in which it is usually written to-day. Our present state of knowledge regarding the elimination of this metalloid has advanced over the views expressed by these authors only in that more quantitative data have been added and that the amount of sulphur in the fuel is now recognised as being highly important.

In the early years of the present century no fewer than five investigators determined that the phosphorus in the slag was present as tricalcium phosphate, $3CaO.P_2O_5$. These early investigators also found that phosphorus could not be readily eliminated unless a considerable amount of FeO was present in the slag.

It was not until more recent years, however, that the general equation for elimination of phosphorus was generally well understood, and that it was recognised that both excess lime and oxidising power of the slag must be considered. The equation for phosphorus elimination is now written as

$$2P + 5FeO + 3CaO \rightleftharpoons 3CaO.P_2O_5 + 5Fe$$

The effect of temperature on elimination of both phosphorus and sulphur was well understood in practice in the early days of steelmaking, low temperature being used for maximum phosphorus elimination and high temperature for sulphur elimination. Furthermore, the necessity for working with a fluid slag was early recognised. Thus a sound basis had been laid for the proper elimination of phosphorus and sulphur.

Even though the basicity of the slag is of first importance in the elimination of phosphorus and sulphur, states the author, we know next to nothing about this important item. The earliest investigators calculated the basicity of the slag by determining the "acidity," the "basic index," the "base/acid ratio," or other terms, all of which were simply ratios of the concentrations of basic to acid constituents in the slag expressed in one way or another. To-day, we use the lime-silica ratio, which is simply another way of expressing exactly what the earlier investigators had in mind. No one as yet has actually determined how much active lime there is in an open-hearth slag, and until such studies are made the important reactions in the basic open-hearth process must still be considered to be applied by empirical methods.

Effect of Iron Oxide

In recent years the iron-oxide content of the metal bath and the reactions of deoxidation have been studied intensively. In rimmed steels we attempt to control the FeO in the metal at a fairly high concentration, in semi-killed steels at a fairly low concentration and in killed steels at a very low concentration. The hydrogen-reduction method of Ledebur was the earliest proposed for the determination of oxygen in steel and for many years the only one. Later, various other methods were developed; namely, cold acid extraction, hot gaseous extraction, vacuum fusion, electrolytic methods, and, more recently, precipitation of oxygen from steel with aluminium to form Al_2O_3 and the determination of the Al_2O_3 by simple chemical analysis.

The most recent information attained by the last-named method indicates that the controlling factor in the oxygen content of the steel is the carbon content. However, slag oxidation and fluidity have an important bearing on the oxidation of the steel after the furnace deoxidisers are added and on the oxidising action of the slag on the metal during tapping and in the ladle. Below about 0.10 per cent. carbon the iron-oxide content of the slag has a more important effect on the oxygen content of the metal than at higher carbons. Last-minute changes in the condition of the slag on rimmed heats have a tremendous effect on the rimming action, which shows that carbon alone does not entirely control the oxygen content of the steel.

Available knowledge of the variables affecting the sulphur, phosphorus and oxygen contents of the metal may be summarised as follows:—

Sulphur.—The sulphur in the metal is lowered by increased basicity, fluidity, and agitation of the slag and by high temperature. High iron oxide and increased sulphur in the charge (including sulphur absorbed from the fuel) make the attainment of a given sulphur more difficult. The FeO effect is often difficult to observe in practice, because high basicity usually causes the slag to be high in FeO.

Phosphorus.—The phosphorus in the metal is lowered by increased basicity and fluidity of the slag, a high FeO content of the slag and by low temperatures. High phosphorus in the charge is an adverse factor to the production of low-phosphorus metal.

Oxygen.—The oxygen content of the metal before deoxidation is controlled by the carbon in the metal and the FeO content of the slag. Above about 0.10 per cent. carbon, the slag is of minor importance, but as the carbon diminishes below 0.10 per cent., the slag becomes more important. After deoxidation, particularly in the furnace, the slag composition and fluidity play an important role in determining the oxygen content of the steel. The effect of temperature has not been definitely determined. It increases the solubility of FeO in iron, affects the carbon/iron-oxide reaction in the metal, and increases diffusion of iron oxide from slag to metal.

In order to arrive at a desired composition of the metal, with particular respect to sulphur, phosphorus and oxygen, it is necessary to carry a definite type of slag, depending upon the analysis of the raw materials. Slag control is primarily a phrase used to describe the effort to produce this type of slag, be that effort directed toward the open-hearth or to the blast furnace. The choice of raw materials entering the blast furnace, with their effect on the composition of the iron, has a definite effect on the slags produced in the open hearth, and constitutes the first step in the control of the open-hearth slag. It is in this phase that the wider aspects of the economies of control first appear in the steelmaking operation. A plant in which the blast furnace is fed with materials that ensure a uniform quality and analysis of pig-iron is a tremendous asset to the open-hearth from the standpoint of slags, but the analysis chosen for the blast furnace may not be the one best suited for lowest over-all costs, and it is on this point that open-hearth slag control contributes greatly to the economies of steelmaking.

Take, for example, a blast-furnace product containing 0.22 per cent. phosphorus and 0.025 per cent. sulphur. The open-hearth operator's troubles may be over as far as these two elements in his steel are concerned, but blast-furnace costs may be excessive compared to those when producing an iron containing 0.30 per cent. phosphorus and 0.040 per cent. sulphur. The intelligent use of a practicable system of slag control in the open hearth will enable the operator to use the iron at a slightly increased cost over that which may be made when using the iron having better analysis. The blast-furnace costs, however, will be much lower on the second analysis, and the savings here may well more than balance the extra cost to the open hearth.

Objects of Slag Control

It may be stated that the ultimate objects of slag control should then be:—(1) To produce a slag in the furnace that will eliminate phosphorus and sulphur to the desired extent without excessive use of lime or excessive loss of iron as oxide. (2) To conserve as far as possible both lime and deoxidisers. (3) To prevent excessive wastage of iron in the slag, on grades that do not have strict phosphorus requirements. (4) To minimise the melting period through the use of as little limestone in the charge as possible. (5) To standardise the conditions of oxidation so that the deoxidising additions will unfailingly produce the desired type of ingot.

Open-Hearth Slags

It is obvious to anyone versed in basic open-hearth operations that the open-hearth slag is variable in its behaviour. Various amounts of lime are left on the bottom at melt, various amounts of lime are dissolved in the slag at melt and various amounts of lime float about in the slag, in one extreme giving the slag a thick, dirty appearance, in the other the impression that huge cakes of ice are floating on a black river. With these variations no one has yet been able to develop methods that permit an exact control over the slag composition at any time, and it is necessary to rely upon the laws of probability in seeking methods of attack.

One can determine experimentally that the lime-silica ratio of the slag is reflected qualitatively in its fluidity, its FeO content, the appearance of a slag cake poured in a definite manner, and in a number of other physical or chemical properties. It is also known by experience that the FeO in the slag is building up throughout the refining period at a rate determined largely by the basicity and the fluidity of the slag. From these qualitative observations it can be said: (1) That early tests give a reasonable idea of the slag qualities of the heat. (2) That the undissolved lime will go into solution in a length of time depending on the composition, fluidity and temperature of the slag. (3) That corrective additions will be assimilated in a reasonably definite length of time and thus influence the build-up of iron oxide in the slag to a certain degree.

Errors in estimates and vagaries in the behaviour of the furnace cause deviations, sometimes more than is desirable. However, one should attempt to proceed in a certain direction in slag conditioning, and the more numerous the signs, and the more rapidly they are interpreted and necessary corrections made, the closer one comes to the desired end-point.

Effect of Silicon in Charge

The primary cause of the variations in the working of open-hearth heats is in the variation of the analysis of the pig-iron used, and the element that is of first importance in the blast-furnace metal is silicon. A reasonable uniformity in this element is most desirable, be the range 0.60 to 0.90 per cent., or 1.00 to 1.30 per cent. Widespread silicon analyses from cast to cast or from furnace to furnace cause havoc with the melting of the open-hearth heats. The open-hearth furnace is usually charged with limestone before the iron analysis is definitely known, and although the operator can vary his limestone charge to some extent this is seldom practicable because the charges have to be made up for some time before the heat is ready. Furthermore, a furnace cannot take excessive amounts of corrective slag additions without serious interference with heat time. Average heat time is greatly affected when the variation in silicon is sufficient to cause some heats to melt extremely high with attendant long duration of the refining period, generally accompanied by some bottom trouble, and other heats to melt "soft" when they are scheduled to make medium and high-carbon grades.

Table I.—*Relation between Silicon in Hot Metal and Slag Analysis.*

Silicon in hot metal, per cent.	Final slag analysis, per cent.		
	SiO_2	CaO	Ratio $\frac{CaO}{SiO_2}$
0.6	10.3	48.7	4.7
0.8	12.0	47.7	4.0
1.0	13.7	46.8	3.4
1.2	15.3	45.9	3.0
1.4	16.8	45.1	2.7
1.6	18.3	44.3	2.4
1.8	19.7	43.6	2.2
2.0	21.1	42.8	2.0

In a furnace charged with 280,000 lbs., the metallic charge consisting of 50 per cent. hot metal, 46 per cent. scrap, and 4 per cent. ore, and with 9 per cent. of limestone (based on metallic charge), the percentage of silica in the finishing slag will change with the silicon content of the iron as shown in Table I.

As the silicon in the hot metal increases, the lime-silica ratio in the open-hearth slag decreases rapidly, if one assumes that a grade of steel is being made that requires a low sulphur content, and that in order to reach this content a lime-silica ratio of 3.5 is required. In the charge shown in Table I a 1.0 per cent. Si iron practically fulfils these conditions. With increasing silicon in the hot metal, more stone must be charged, or burnt lime must be added during the working of the heat. The amount of burnt lime required would be as shown in Table II.

Table II.—*Relation between Silicon in Hot Metal and Lime Required for Correction.*

Silicon in hot metal, per cent.	Burnt lime in lbs. to give lime-silica ratio of 3.5	Silicon in hot metal, per cent.	Burnt lime in lbs. to give lime-silica ratio of 3.5
0.6	None	1.4	4,800
0.8	None	1.8	7,000
1.0	300	1.8	9,200
1.2	2,500	2.0	11,400

If these additions are to function properly, they must be put into the furnace reasonably early so that the CaO may be effective in desulphurisation. Heavy additions of this type chill the bath to such an extent that the heat will be delayed and extra costs will be involved in both production and fluxes.

The same principles apply to phosphorus elimination with the added effect of the lime-silica ratio on the behaviour of the FeO content of the slag. Thus, with high-silicon iron, it is not sufficient to add lime only; iron oxide, generally in the form of roll scale, must also be added to raise the iron-oxide content to the point where satisfactory phosphorus elimination is assured.

Corrections on Charging

The open-hearth operator is faced with a real problem in varying the limestone charged. This is particularly true if the hot metal comes from more than one furnace. If the silicon does not change to the extent that he has estimated, the furnace may be still undercharged or overcharged with lime. If overcharged, soft melting heats may result, with resultant lengthening out of the heat time in the furnace. This naturally leads to caution in changing the stone charged.

With close co-operation between the blast furnace and open hearth, and with frequent analyses or calculation of the silicon content of the iron in the mixer, the first step in slag control can be made. This step cuts down the work to be done by corrective additions later in the heat.

The silicon content of the iron is usually known with fair accuracy when the iron is ready for charging in the open hearth. Shortly after the hot metal is added it may be advisable to make an addition of lime in some form in order to compensate for high silicon and from 1,000 to 3,000 lbs. of CaO may be added at this time. In some plants an early addition of lime is made on all heats in order to minimise erosion of the furnace banks by the siliceous slag which forms early in the heat.

Estimation of Slag Composition

As the melting of the heat proceeds and lime begins to show in the slag, the true characteristics of the charge begin to be seen. There are a number of indicators, which serve to give a good approximation of slag composition during this period. First, there is the trained eye of the melter. There are also observers who are conversant with slag characteristics and analyses. Second, rapid methods of chemical analysis are now available so that the total iron (usually expressed in FeO) may be returned from the laboratory in about 10 min. from the time the sample is taken, with a somewhat longer time required for a silica analysis. Either of these analyses can be of great help if taken at the proper time, the FeO not only for an indication of the state of oxidation of the slag, but as a guide to its silica content. Third, there are numerous physical characteristics of the slag, which reflect composition with varying degrees of accuracy. Some of these are immediately apparent to anyone who has carefully watched a heat of basic steel, two characteristics in particular having been widely used by the furnace operators from the earliest days of steel melting. These were the consistency of the slag and the colour of slag remaining on the test spoon after the withdrawal of steel samples from the furnace. Tests that will give a better approximation of composition have more recently been developed as the desire for more accurate control has grown, and are particularly useful when a melter has under his guidance too many furnaces to give exclusive attention to any one, especially during the early periods of the heat.

Appearance of Slag in Furnace.—The appearance of the slag in the furnace during the melting period is indicative of its composition and of its future requirements. Charges too high in silicon will show a thin, watery slag, usually low in iron oxide, and with numerous lumps of lime apparently indifferent to the laws of solution. Research with the petrographic microscope has shown that these lumps are coated with a high-melting-point layer of dicalcium silicate, which can only be fluxed away by the action of fairly high concentrations of iron oxide or spar in the fluid slag. Charges too low in silicon result in a slag thick with lime, with very small amounts of fluid slag observable. Such slags are generally of medium or high iron-oxide content, and are easily "shaped up" by additions of roll scale, fluorspar, or sand. (Pioneer work on the advisability of making acidic additions to the open-hearth heat was begun by Cook as early as 1928.) How much of any addition should be made is a question of personal judgment and the success of the slag conditioning depends entirely on the skill and experience of the melter.

(*To be continued.*)

Effect of Welding on the Structures of Some Cast and Wrought Steels

(*Continued from page* 72.)

ductility and impact resistance, the most reliable method is microscopy. With a penetration hardness tester, even a small penetrator is likely to miss the thin, hard, brittle layers that may be formed. When these layers are known to be present, they may be so localised and small that the penetrator either straddles the layer or may slide off to one side. The penetration hardness test gives little or no evidence of coarsening. A "scratch hardness" tester of micro-character might be quite useful. For a measurement of coarsening, in many cases the coarsened region is too narrow to be analysed with a fracture test.

With the samples available, microscopy proved highly useful and reliable. It may be said that physical mensuration (as by tensile-ductility, impact tests, fatigue test) is to be preferred. There is some merit to this argument, and in the authors' opinion such methods, backed up by microscopy, would be very useful. A good micro-structure ensures good physical properties, a bad one is always dangerous.

Vitreous Enamelling Section

Glass Technology as Applied to the Study of Vitreous Enamels

By R. J. SLAWSON, M.Sc.TECH.

(*Continued from page* 13.)

CHEMICAL COMPOSITION

Classification

The classification of glasses according to their composition has been most clearly accomplished by E. Zschimmer. The glasses are divided into twelve classes according to the acidic radicals present in them. Almost all enamels fall into group VI of Table II, but some may also be classified under group XII.

Effect of Various Constituents

The general effect of a number of constituents is shown in Table III, and the average compositions in Tables IV and V. None of the attempts which have been made to express these effects in a quantitative manner in order that the properties of a glass could be obtained by calculation has been entirely satisfactory, though for simple glasses several methods are reasonably accurate.

TABLE II.—*Classification of Glasses According to E. Zschimmer.*

I. Single substance, *e.g.*, Se, SiO_2, B_2O_3, BeF_2.
II. Silicates, *e.g.*, common window glass.
III. Alumino-silicates.
IV. Boro-silicates.
V. Alumino-boro-silicates.*
VI. Alumino-borates.
VII. Borates.
VIII. Silico-phosphates.
IX. Alumino-silico-phosphates.
X. Phosphates.
XI. Boro-phosphates.
XII. Fluorides.*

* Enamels.

The general method adopted is the application of empirical factors to the percentage composition of the glass expressed either as oxides or as silicates plus free silica. The silicate method sometimes appears more accurate, but is much more cumbersome. With such complicated glasses as enamel frits, the oxide method (with slight variations) is certainly the most useful. The factors given by Mayer and Havas for the thermal expansion, for instance—although they may not be as accurate as those of English and Turner—are more complete and, if used with a due appreciation of their limitations, can be of considerable use to the enameller.

The mean specific effect of each constituent in simple glasses is comparatively easy to determine, but, as glasses become more complicated, the problem becomes more and more difficult, as effects of one constituent are masked by those of others. When one comes to enamels, the problem cannot be tackled directly, and the factors must be obtained from the study of simple glasses. Even for such glasses, the factors given are mean values only, and there is no proof that they hold for glasses other than the type for which they were determined. Too much reliance on these factors, useful though they are, is only likely to lead to trouble.

They are certainly not sufficiently accurate to enable one to produce an enamel of a definite thermal expansion, but they are very useful when a change has to be made in a certain frit, and it is desired to calculate what other change must be made in order to compensate for the resultant change in thermal expansion. Factors of varying degrees of accuracy are in existence for the calculation of many of the properties of glass, *e.g.*, density, scratch hardness, elasticity and mechanical strength.

Figs. 6 and 7 show two reasons why the factors for glass should be applied to enamels with caution in the cases of aluminium and particularly boric oxides. Alumina, it will be seen, does not have the same specific effect at differing concentrations, while boric oxide actually shows a reversal in the effect produced. The amount of boric acid present in an enamel is usually greater than the critical value, which varies with the composition of the glass, while in a glass it is usually less. The factor for boric acid in glasses and enamels will therefore not be

TABLE III.—*General Effects of the Commoner Glass Constituents.*

SiO_2 ..	High melting point. High viscosity. High chemical resistance. Low expansion.
B_2O_3 ..	Easy melting. Low viscosity. High setting rate. High surface hardness. Very low expansion.
Na_2O ..	Easy melting. Low viscosity. Slow setting. Corrosive. Low chemical resistance. Very high expansion. Low mechanical strength.
K_2O ..	Similar to Na_2O, but rather higher viscosity.
PbO ..	Easy melting. Slow setting. High density. Very corrosive.
BaO ..	Assists melting. Corrosive.
CaO ..	Fluxing action at high temperatures. Very quick setting. Excess causes devitrification. High elasticity.
ZnO ..	Refractory. High viscosity. Increases chemical resistance. Low expansion.
MgO ..	Refractory. High viscosity. Slow setting. Low expansion. High mechanical strength.
Al_2O_3..	Refractory. Very high viscosity. Slow setting. Prevents devitrification. High chemical resistance. Low expansion. High mechanical strength.

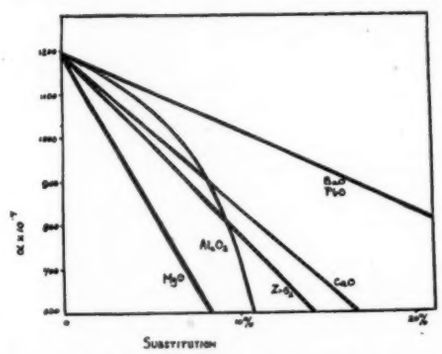


FIG. 6.—EFFECT OF VARIOUS OXIDES ON THERMAL EXPANSION.
(Basic glass as in Table VII.)

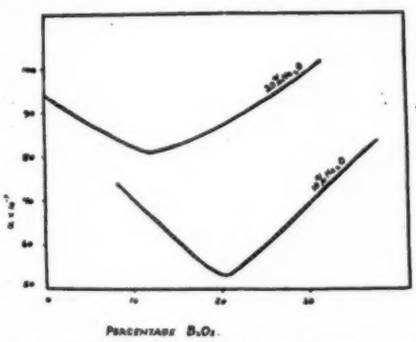


FIG. 7.—EFFECT OF BORIC OXIDE ON THERMAL EXPANSION.
Basic glasses:—$(90 - x)\ SiO_2 . 10Na_2O . x\ B_2O_3$
$(80 - x)\ SiO_2 . 20Na_2O . xB_2O_3$.
(By weight.)

TABLE IV.—*Compositions of Some Typical Glasses.*

	SiO_2.	B_2O_3.	As_2O_5.	Sb_2O_3.	Al_2O_3.	Fe_2O_3.	CaO.	MgO.	ZnO.	BaO.	K_2O.	Na_2O.
Modern bottle ..	69.7	—	0.5	—	0.5	0.25	17.4	0.6	—	—	—	11.2
Window glass—												
Fourcault.. ..	70.6	—	—	—	0.77	0.11	10.6	0.1	—	—	—	17.2
Hand made ..	72.1	—	—	—	1.43	0.15	13.5	tr.	—	—	—	12.5
Libby Owens ..	72.1	—	—	—	1.06	0.15	11.2	2.6	—	—	—	12.0
Chemical glass ..	59.3	9.6	—	—	7.6	0.1	5.0	1.7	6.2	—	2.9	8.8
	81.3	10.1	—	—	3.9	0.1	—	—	—	—	0.4	4.2
Heat-resisting ..	75.3	11.3	—	—	3.0	0.1	0.5	—	2.8	—	1.2	6.3
	80.6	11.9	0.7	—	2.0	0.1	0.2	0.2	—	—	0.6	3.8
Jena 1930	74.5	4.6	—	—	8.5	—	0.8	0.1	—	3.9	—	7.7
Thermometer—												
Jena 5911 ..	72.0	12.0	—	—	5.0	—	—	—	—	—	—	11.0
Verre dur ..	71.5	—	—	—	—	—	14.4	—	—	—	0.5	12.6
Natural glass .. (Obsidianite)	74.1	—	—	—	12.97	2.7	0.1	0.3	—	—	5.1	3.9

TABLE V.—*Average Composition of Some Typical Enamel Frits (Major Constituents).*

	SiO_2.	B_2O_3.	Al_2O_3.	PbO.	CaO.	ZnO.	NaKO.	MgO.
Sheet-iron ground coat	45—55	10—20	5—10	—	0—10	—	15—25	—
Sheet-iron cover coat	45—50	10—20	5—10	—	0—5	0—5	15—25	0—2
Wet-process cast iron	25—45	10—20	4—6	0—35	0—10	0—10	10—20	0—4
Dry-process cast iron	25—50	8—20	5—10	0—20	0—2	0—15	10—30	0—2

the same. These divergencies from the additive effect shown by alumina and boric oxide obtain for other properties as well, and the reversion point for boric oxide in a given base glass is roughly the same for any property.

It has been shown in what manner the viscosity of the enamel applies to the firing process, but in order to forecast the effect on the firing of a particular alteration in an enamel it is necessary to examine not only the effect of constituents on the viscosity at a given temperature, but also the effect of those constituents on the viscosity/temperature curve.

Fig. 8 gives a rough idea of the type of results which may be obtained. Owing to the reversion effect of boric acid, the curve for this material probably does not apply to enamel glasses. It will be seen that different glasses have very different viscosity/temperature curves. Thus lime glasses show a very sudden change in viscosity; in glass works' practice, they are known as "quick setting." Though variations in setting rate of enamels will be largely masked by the effect of the high percentages of alumina usually present, the effects may still be seen. Lead enamels, for instance, are well known in having a very large range in which they can successfully be fired. Enamels with a high setting rate can only be fired in a small range of temperatures. Outside this small range the viscosity, as shown in Table VII, changes so rapidly that the enamel is either not fired or else runs from the edges.

TABLE VI.—*Comparison of Expansion Factors Given by Various Authorities.*

Oxide.	Winkleman & Schott.	English & Turner.	Mayer & Havas.	Fetterolf & Parmelee.
SiO_2 ..	0.8	0.15	0.8	—
Al_2O_3 ..	5.0	0.42	5.0	—
B_2O_3 ..	0.1	−0.98*	0.1	—
Na_2O ..	10.0	12.96	10.0	12.5
K_2O ..	8.5	11.7	8.5	—
PbO ..	3.0	3.18	4.2	—
ZnO ..	1.8	2.1	2.1	1.85
CaO ..	5.0	4.89	5.0	—
BaO ..	3.0	4.2	3.0	5.7

* Does not apply after reversion point.

TABLE VII.—*Effect of Various Oxides on Chemical Durability.*

Basic Glass 6 SiO_2.(2−x) Na_2O × {Ro, R_2O_3, RO_2}

Reagent.	Water.	HCl.	Na_2CO_3.	NaOH.
Durability	ZrO_2	ZrO_2	ZrO_2	ZrO_2
	SiO_2			
decreases	Al_2O_3	Al_2O_3	Al_2O_3	Al_2O_3
↓	TiO_2	—	—	—
	ZnO	ZnO	—	—
	MgO	CaO	—	—
	PbO	TiO_2	—	—
	CaO	PbO	PbO	—
	BaO	MgO	BaO	—
	Na_2O	BaO	—	—
	K_2O	—	—	—
	Li_2O	—	—	—

Colour

There is very little in common between the methods adopted by the glass maker and the enameller in producing coloured products, though the elements used to impart the colour are in many cases the same. The glass maker usually desires a transparent colour and produces this by the addition of various materials (indicated in Table VIII) to his batch. Only in the case of dark blues and blacks does the enameller produce coloured frits in this way.

Opacity

The enameller has the choice of two ways of producing opacity:—(1) By the use of an opaque frit; and (2) by the addition of opacifier, *i.e.*, some material that is insoluble in the frit, at the mill.

The glass maker may only use the method of making the glass itself opaque, but in general he does not require as high a degree of opacity as does the enameller. In fact, except for a few cases, he desires only sufficient opacity to obscure a source of light and not to cut down by more than a very little the percentage of light transmitted through the glass.

Opacity in glasses is caused by multiple reflections, refractions and scattering of light at the numerous interfaces between components of varying refractive indices present in the glass. The greater the number of these interfaces and the greater the dispersion of the various components throughout the mass of the glass, the greater will be the opacity.

The presence of these interfaces results either from the insolubility of one or more of the batch constituents or from the separation of some material either in the form of small crystals or as an emulsion during the cooling process. The enameller makes use of both types of opacifier in the production of opaque frits. Tin oxide is an example of the insoluble type of opacifier, while arsenic in lead frits is a fine example of the other type. If the frit containing an opacifier of the insoluble type is melted at too high a temperature or for too long, the opacifier may be partially, or sometimes totally, dissolved and the opacity destroyed; they are said to have been burnt out, but, strictly speaking, they have been burnt in. A lead-arsenic enamel, if cooled too rapidly, may be found to have practically no opacity, and it is said to have failed to strike. Reheating will remedy this fault, and in fact will often improve the opacity which has been "struck" in the ordinary way.

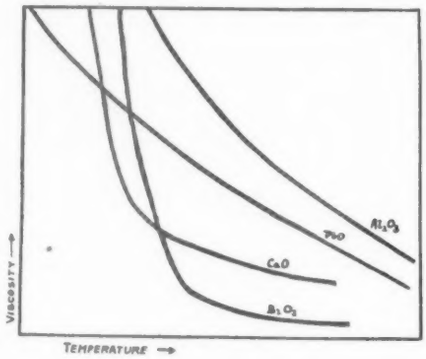


FIG. 8.—GENERAL EFFECT OF VARIOUS OXIDES ON VISCOSITY/TEMPERATURE CURVE.

The commonest opacifiers used in enamel frits are the various compounds of fluorine. The fluorine compounds seem to go into solution during melting and to separate on cooling. There is considerable controversy as to the precise function of fluorine in opacification.

It is in order to reduce the solubility of opacifiers in the frit that the enameller makes use of the second method of producing opacity—the mill addition. In this way the time during which the opacifier is in contact with molten material, and the temperature, are enormously reduced, enabling the enameller to use either more soluble opacifiers which are often cheaper, or less in quantity of the more expensive materials.

Melting Process

In both industries the raw materials are very much the same, and the melting process is similar. In glass making, the temperatures involved are very much higher and the melting process is carried very much further than in the case of enamels. In glass melting, it is very important that the glass should be melted until it is absolutely homogeneous and free from gas bubbles. In enamels it is usually desirable that the melting should continue only until the batch is completely melted. In each industry the batch materials are mixed, usually in some form of mechanical mixer, transported to the furnace and charged on.

An important constituent of any batch, the presence of which is often forgotten, is moisture. It affects both the efficiency of mixing the batch and also of melting it. If a batch is mixed in too dry a condition, it stands a very good chance of segregating if it is not charged on to the furnace immediately, and so the beneficial effect of good mixing is lost and melting is less efficient. Table IX shows the amount of segregation possible under conditions of slight vibration during the short space of one hour. Excessive moisture, on the other hand, reduces both the efficiency of mixing and of melting.

TABLE VIII.—*Some Materials Used for Colouring Glass.*

FeO ..	Green ..	Cu		Ruby.
Fe_2O_3 ..	Brown ..	Ag		Yellow.
NiO ..	Grey-green ..	Au		Ruby.
MnO_2 ..	Purple ..	Se		Ruby.
CuO ..	Blue-green ..	Te		Brown.
Cr_2O_3 ..	Green	C	}	Amber.
CoO ..	Blue	S	}	
UO_2 ..	Yellow green ..	Fluorides	}	Opal.
	Fluorescent ..	Chlorides } In Pb	}	
		Sulphates } glass.	}	
		Phosphates ..	}	

The amount of water which may be present in a batch without loss of melting efficiency varies with the composition of the batch, but the most efficient mixing is obtained with between 3 and 4 per cent. of moisture. Water in the batch, either present as moisture or combined in certain of the constituents, also affects the amount of loss of volatile materials during melting. The greater the amount of water present, the greater, for instance, is the loss of boric oxide. The batch materials, particularly the more refractory ones, should be as finely ground as possible in order to increase the surface in contact with the more easily fused materials. Fine grinding does not affect the temperature at which reaction between the materials can occur, but it does enormously increase the rate of reaction.

The complexity of enamels in general and the consequently enormous number of eutectic mixtures which may be formed make a study of the actual process of melting very difficult. It is indeed often difficult to say, in a given batch, the precise *rôle* of certain constituents. Thus it has already been shown that boric oxide reverses its functions when present in more than a certain amount. Aluminium oxide, in most cases, increases the melting temperature but in certain cases, if added in small quantities, it can effect quite a large decrease.

TABLE IX.—*Effect of Vibration on Segregation of Batch Materials.*

Sample.	Location.	SiO_2. Per cent.
1	Top of batch ..	78.15
2	,, ,, ..	78.32
3	Middle of batch	79.05
4	,, ,, ..	79.36
5	Bottom of batch	80.10
6	,, ,, ..	79.82
7	Batch before test	78.70

One thing that should be remembered is that the mere fact of making a certain mixture and melting it does not guarantee that the same result will be obtained in every case. In fact, if furnaces of different types are used, it is very unlikely. The furnace conditions can affect the product seriously; in the case of enamel frits,

they can affect the product almost as much as the composition of the batch. At different temperatures and between different furnaces there are very great differences in the amount of volatile materials lost during melting; incorrect temperature, excessive draught, and, particularly in the case of antimony, insufficient oxygen will all cause excessive loss of volatile materials. Excessive temperature may not cause excessive loss; in some cases, that of the selenium ruby glass for instance, the reverse is the case. If the furnace is too cold when the batch is charged, the selenium is often completely vaporised and lost before the batch has sintered sufficiently to hold it.

Testing Methods

In the testing of enamelled iron, the problem in the case of mechanical properties is rather different from that of testing glass. Glass is homogeneous and mechanical tests are usually conducted until fracture occurs; enamelled iron, on the other hand, consists of two materials, one of which is vitreous and brittle and the other more or less malleable and in any case immensely stronger. The purpose of the mechanical testing of enamelled iron is therefore directed more to the testing of the strength of the bond between the iron and the glass. The methods of the glass worker are not, therefore, of much use to the enameller.

The methods tried up to the present for the determination of surface hardness do not seem to be very reliable. The chemical resistance of the surface can, however, be tested by the same methods in the case of both glass and enamels. The precision test for the chemical resistance of glass has been recently described by Abbott, but this test takes no account of the condition of the surface, the resistance of which may be varied greatly by the effects of working and annealing. In the same way, an enamel surface is affected by the firing process.

Two methods which may be used for the estimation of the chemical durability of glasses might easily be applied to enamels for the purpose of rapid testing. Both of these methods depend on the use of a sensitive indicator which shows the extraction from the glass surface of alkaline material.

The first method, due to Mylius, involves the use of a solution of iodoeosin in ether-water mixture. Any alkali extracted is shown by a pink coloration either in the solution or on the surface of the glass. The other method is intended for the testing of medicine bottles and the indicator used is narcotine hydrochloride solution, which will show a precipitate if alkali is extracted. The time taken to give the pink coloration or the precipitate is an indication of the chemical durability of the surface.

This Paper has of necessity had to be brief, and many branches, particularly those not directly connected with glass itself, of the subject of glass technology have had to be omitted. Nevertheless, the author hopes that he has been able to show that the two industries have a good deal in common, and he personally would be very pleased to see an increase in collaboration between them. In conclusion, his thanks are due to C. E. Ramsden & Company, Limited, for permission to present this Paper, and to the Department of Glass Technology for the information on glass included in it.

The Moustache Dust Filter

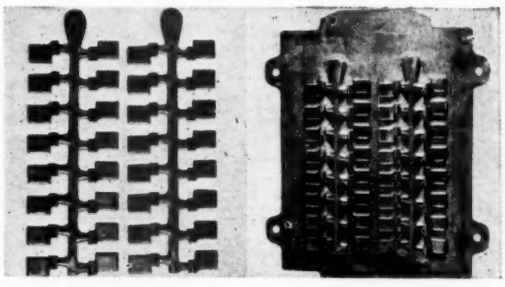
The British Columbia Department of Mines suggests that Nature placed a moustache on the face of man for a purpose, and seems to have intended it as a filter. Silicosis being caused by inhaling particles of crushed rock which lodge in the lungs, miners are advised to grow moustaches to avoid silicosis. The bigger the moustache, the less likely is silicosis to develop, it is maintained.

Fusible Metals in the Foundry

Until a few years ago the chief applications of fusible metals were for electrical fuses, fire alarms and sprinklers, temperature indicators, low melting-point solders and similar devices, but they have now acquired great importance in the tool-shop and foundry. The development of fusible alloys for these purposes is largely due to the combined efforts of the Cerro de Pasco Copper Corporation of the United States and their associated company in London, Mining and Chemical Products, Limited, who market accurately compounded alloys for the following purposes:—(1) Mounting of dies and punches in press-tool work ("Cerromatrix"); (2) casting of models and patterns for foundry work and the production of moulds by electro-deposition ("Cerrobase"); and (3) bending of tubes and rolled or extruded sections ("Cerrobend").

All the alloys contain a preponderating proportion of bismuth which conduces to their low melting points and also causes them to expand slightly on solidification, a property that in each application is of the highest importance.

Of chief interest to our readers is the "Cerrobase" alloy of lead and bismuth, which is used



A MULTIPLE PATTERN IN "CERROBASE" MADE FROM A SINGLE WOODEN PATTERN, AND THE ALUMINIUM MATCHPLATE CAST FROM THE MULTIPLE PATTERN.

mainly as a master pattern metal. It melts at 255 deg. F. (124 deg. C.), is very fluid when molten, casts well in sand, plaster, wood or paper moulds, and has a very slight expansion on solidification, usually just enough to compensate for the loss in size when the replica cast from it in sand moulds is cleaned. Castings in plaster and similar moulds are exact in size. When constructing multiple patterns a number of replicas of the original wooden master patterns can be cast from an ordinary ladle heated over a gas ring, and then soldered to a brass runner.

This alloy is very suitable for casting models to be copied on pantographic engraving machines as it withstands the pressure and friction of the chaser and facilitates the production of accurately dimensioned copies. It is sometimes used for taking proof castings of forging dies and press moulds. The material has a specific gravity of 10.3, a tensile strength of 2.7 tons per sq. in., and a Brinell hardness of 10.2.

Contracts Open

Chapel-en-le-Frith, August 17—Providing and laying of about 1,700 yds. of 3-in. spun-iron pipes, for the Rural District Council. Brady & Partington, engineers, Chapel-en-le-Frith. (Fee £5 5s., returnable.)

Faringdon, August 3—Supply and laying of approx. 4,752 yds. of 10 in. dia. spun-iron rising water main, etc.; supply and laying of approx. 5,812 yds. of 12 in. dia. spun-iron, gravitating water main and 8-in. and 3-in. branch mains, with fittings, etc., for the Rural District Council. Mr. K. M. Hart, engineer, Council Offices, London Street, Faringdon, Berks. (Fee £4 4s., returnable.)

South African Blast-Furnace Practice

A Paper prepared by MR. R. R. F. WALTON for presentation to the autumn meeting of the Iron and Steel Institute bearing the title "The Practical Side of Blast-Furnace Management with Especial Reference to South African Conditions," contains information about the Newcastle plant, as well as the Pretoria plant of Iscor. The following extracts have been made as being of interest to our readers.

Ladle Practice

The hot-metal ladles are of the enclosed type and hold 60 short tons. They have a course of insulating brick next to the shell and two courses of firebrick. It is customary to get about 300 to 350 casts, after which the inner course is renewed. With this type of ladle it is necessary to clean up the throat each time they come back from the melting-shop or casting-machine, especially if there has been much delay in pouring. Occasionally it is necessary to burn accumulations off the lip with oxygen.

Slag ladles are simply grouted with clay-wash. Originally cast-iron pots were used, but were later replaced by steel pots, which gave about four times the life. Instead of being supported in the collar of the carriage by cast-on lugs, they are now held in a basket of steel flats which gives support all round the ladle and reduces warpage.

Pig-Casting Machine

This item of the plant gives little trouble, provided that ample water is available and all sprays are kept in good repair. Those on the conveyor rails at the pouring spouts and on the shot plates are kept going to prevent metal from building up, and a labourer is stationed at the latter point to rake away the shot as it is formed. Careful pouring and attention to the lime-sprays are essential to keep scrap down to a minimum. It has been found very helpful to place 30-lb. rails, spaced so that the lime-sprays can still reach the moulds, over the lime-vat and below the moulds as they return in the inverted position. This prevents pigs stuck in the moulds from falling on to the lime-sprays or tank. Especially when casting basic metal, it is necessary to have a man with a chisel bar near the top of the strand to ease up the pigs before they reach the discharge shute.

More Export Groups

The following new export groups have been formed. The addresses are those of the secretaries:

Agricultural Machinery and Implement Manufacturers, 1, Broad Street Place, London, E.C.2.

Perforated Metal, 58, Victoria Street, London, S.W.1.

Rail and Telegraph Accessories, 25, Bennetts Hill, Birmingham, 2.

Rubber and Plastics Machinery, Midland Bank Buildings, Spring Gardens, Manchester.

Safe and Strong Room Plant, Federation of British Industries, 21, Tothill Street, London, S.W.1.

Bright Steel Bar, Williams Deacon's Bank Chambers, Church Street, Sheffield, 1.

Electric Vehicle, 2, Savoy Hill, London, W.C.2.

Fire Extinguisher, 6, Martin Lane, Cannon Street, London, E.C.4.

Fuel Oil Burner, 69, Cannon Street, London, E.C.4.

High Conductivity Copper and Alloys, 52-54, High Holborn, London, W.C.1.

Power Transmission, Crofts (Engineers), Limited, Thornbury, Bradford, Yorks.

Pumps, York Mansion, 94-98, Petty France, London, S.W.1.

Steam Raising Plant Accessories, 14, Old Square, Lincoln's Inn, London, W.C.2.

Woven Wire, Midland Bank Buildings, Spring Gardens, Manchester, 2.

The Week's News in Brief

Trade Talk

THE IRONFOUNDERS' NATIONAL CONFEDERATION is now the largest trade organisation in the foundry industry.

AN ORDER to be made by the Minister of Labour will require the occupier of any named factory to make arrangements for part or whole-time doctors, nurses, and officers to supervise the welfare of persons employed.

CLYDE SHIPYARD WORKERS are to broadcast on August 6. The programme will be produced by Mr. Alan Melville as part of Mr. Herbert Morrison's scheme for keeping Great Britain informed of the all-round improvement in industrial production.

MR. T. J. HORGAN, of 30, Haddington Road, Dublin, has been appointed sole agent in Eire for the Metropolitan-Vickers Electrical Company, Limited. The company's agent for Northern Ireland will be, as hitherto, Mr. A. E. McConnell, 55, Waring Street, Belfast.

METAL TRADERS, LIMITED, propose to return to holders 18s. per £1 unit of stock issued. The firm, which has an issued capital of £415,760, has come to this decision in view of the fact that trading in most commodities is now under Government control and that, therefore, the company's opportunities for doing business are very much restricted.

A MEETING of the National Planning Committee in Bombay recently adopted a resolution to the effect that the establishment of a heavy engineering industry for the manufacture of heavy machinery of all kinds was necessary for the advancement of India, for the development of its industries and for the organisation of its defence. The new industry would include the manufacture of heavy machinery of all kinds, heavy forgings, boilers, machine tools, locomotives, railway carriages and wagons, heavy engines, etc. The paramount consideration, it was stated, must be the national interest from the point of view of planned economy. Existing plants producing heavy machinery should be encouraged to function where they could do so on an economic basis and advantageously to the nation.

THE EMPIRE GALLANTRY MEDAL has been awarded to John Henry Farr, foundryman, and the medal of the O.B.E. (Civil Division), for meritorious service, to his brother William Douglas Farr, also a foundryman. When an explosion occurred in a factory in the south of England, John Farr, despite grave danger due to molten metal and the risk of electrocution from loose high-tension cables, removed a colleague from the danger zone. He then returned to the foundry with his brother, Douglas. They cleared two furnaces each containing 1,000 lbs. of molten aluminium, in spite of falling debris, the dangerous condition of the structure and roof, and in complete darkness. The plant was restored to production days sooner than would otherwise have been the case. The two men are brothers of Tommy Farr, the former British heavy-weight boxing champion.

AS A RESULT of war conditions, the management of the A. B. Burton concern of Summer Road, Thames Ditton, has decided to close down that world-famous art foundry. The late Mr. Burton took possession of the foundry in 1900, having previously been in business at Kingston. Actually, he served his apprenticeship at the Thames Ditton foundry when it was owned by Mr. Drew. Mr. Burton personally supervised the foundry until his death in 1933. During this period and until the war, statuary was cast from the works of many famous sculptors of the day, including Sir Goscombe John, Sir George Frampton, Sir Thomas Brock, Sir Alfred Gilbert, Mr. W. Reid Dick, Capt. Adrian Jones and Mr. C. Sargeant Jagger. The Eros statue in Piccadilly, which was cast in a foundry off the Tottenham Court Road, was repaired at Thames Ditton. Well-known pieces of sculpture cast in the Burton foundry include the Quadriga peace memorial on Constitution Hill, and the memorial to Queen Alexandra at Marlborough House. The foundry was once visited by the King and Queen, when they were the Duke and Duchess of York.

THE COMMITTEE ON PUBLIC ACCOUNT, in its Second Report, refers to the special procedure adopted for the purchase of steel shelters. It recalls that after negotiations with the British Iron and Steel Federation, an initial order for 100,000 tons of corrugated sheets was placed in January, 1939, subject to approval of specification and price, with the British Iron and Steel Corporation, the commercial organisation of the industry. This order was extended after approval of designs, and by June, 1939, orders for 2,505,000 shelters and for materials for strengthening 200,000 basements had been authorised at a total cost of more than £19,000,000, of which the sum of £16,100,000 was for the shelters. The Committee states that it is not satisfied that the machinery established by the Iron and Steel Federation, with the approval of the Import Duties Advisory Committee, for regulating the general price level of the main products of the steel industry was necessarily the most appropriate for determining the specific prices of the material for shelters. "No industry," it is added, "should be exempt from an obligation to submit its costs to investigation by Government accountants for the purpose of determining the prices to be paid under non-competitive contracts with Government Departments." The Committee recommends that the present powers of the Ministry of Supply should be used to ensure that the prices paid for steel supplies for the public service are fair and reasonable.

THE ORDER of the Minister of Labour establishing compulsory arbitration in industrial disputes during the war and prohibiting strikes and lock-outs, under severe penalties, came into force on Thursday, July 25. The Minister has appointed Mr. Justice Simonds to be chairman of a National Arbitration Tribunal, together with Sir John Forster and Sir Hector Hetherington. There will, in addition, be two representative members of the Tribunal chosen from panels approved by the British Employers' Confederation and the General Council of the Trades Union Congress. Sir John Forster is one of the chairmen of the Industrial Court, and Sir Hector Hetherington has had much experience in industrial conciliation. Any dispute, existing or apprehended, may be reported to the Minister by either party to it, and the Minister will refer such a dispute for settlement by any suitable machinery in the industry. If there is failure to reach a settlement, or if a settlement is unduly delayed, the Minister may refer the matter to the National Arbitration Tribunal for an award. Any settlement of a reported dispute, whether by agreement, decision, or award, is binding on the employers and workers concerned. It is also laid down that all employers shall observe terms and conditions of employment not less favourable than "the recognised terms and conditions," which are defined as terms and conditions of employment which have been settled through machinery of negotiation or arbitration by organisations of employers and trade unions representative respectively "of substantial proportions of the employers and workers engaged in that trade or industry in that district." The Order prohibits lock-outs or strikes unless a dispute has been reported to the Minister and also after a dispute has been reported unless the Minister has not referred it for settlement within three weeks of the date of the report.

Obituary

MR. SIDNEY BURKITT, late works manager of the Hydraulic Engineering Company, Limited, engineers and ironfounders, of Chester, has died at his home at Openshaw.

MR. PERCY J. SIMS, for 27 years Scottish branch manager of the General Electric Company, Limited, died recently in his 67th year. Going to Glasgow from Yorkshire, Mr. Sims joined the G.E.C. in 1893. He retired in 1937.

MR. WM. MORRIS, general works manager and a director of the Anderston Foundry Company, Limited, Middlesbrough, who had nearly completed 50 years' service with the firm, died recently at Redcar. Mr. Morris had been a member of the Redcar Town Council for 18 years and was twice Mayor of the borough.

MR. PETER MURDOCH, a departmental overseer at the Diamond Foundry, Luton, for 33 years, has died in a nursing home at the age of 77. He retired 7 years ago. He was one of the original employees of the Luton foundry, being brought from Falkirk when the company transferred their works from that town to Bedfordshire.

Personal

MR. A. S. WALL, pig-iron representative of the Stanton Ironworks Company, Limited, for South Wales and the West of England, has removed from Bristol to 1, The Green, Llandaff, Cardiff.

MR. H. M. LANE, who is well known in European foundry circles, having designed one of the largest French motor-vehicle continuous casting shops, has joined the staff of Paul Maehler Company, of Chicago, as research engineer.

MR. W. R. BLAIR, M.C., LL.B., has relinquished his position as director of the Ironfounders' National Confederation, as developments in the light-castings industry necessitate his full attention as director of the British Ironfounders' Association.

MR. D. G. FRASER, who recently retired from the post of manager at Dalzell Works, of Colvilles, Limited, has been honoured by the staff. A gift of money in Treasury notes was handed to him by Mr. John Craig, C.B.E., D.L., J.P., chairman of the company, at a recent gathering. Mr. Fraser joined the firm during the last war as an engineer at Clydebridge Works, where he became manager before his appointment to Dalzell Works.

MR. E. H. GREEN, secretary, joint general manager and a director of the Airedale Foundry of Kitson & Company, Limited, Leeds, completed on July 27, half a century of service with the undertaking. Beginning in 1890 in the works after leaving Leeds Central Higher Grade School, he was transferred to the secretarial department in 1893, became assistant secretary in 1912, secretary in 1916, and in 1927 was given a seat on the board of directors and the post of joint general manager as well as secretary. Mr. Green is also a director of T. Balmforth & Company, Limited, boilermakers, of Luton, and of the Shropshire Iron Company, Limited. He is on the executive of Leeds and District Association of Engineering Employers.

AT THE LAST MEETING of the Committee of the Ironfounders' National Confederation, Mr. A. J. L. Wallace, who, since the beginning of the year, had been acting as personal assistant to the director, Mr. W. R. Blair, was appointed secretary of the Confederation. Mr. Wallace is a graduate (M.A.) of St. Andrews University. He passed into the Regular Army through the University in 1911 and served with the Indian Army throughout the whole of the Great War. Relinquishing his commission some years after the war, he joined the Honorable Society of the Inner Temple and was called to the Bar in 1928. During the intervening years, he has been wholly engaged in the setting up and conducting of trade organisations of both manufacturers and distributors. His long and varied experience of the diverse aspects of associated effort in industry may well prove valuable to the I.N.C. at this time.

Will

AULD, JOHN, of David Auld & Sons, Limited, Whitevale Foundry, Glasgow £171,303

R. J. RICHARDSON & SONS, LTD.
COMMERCIAL STREET, BIRMINGHAM, 1
Airless and Pressure Blast Cleaning Plants
AIR COMPRESSORS
DUST ARRESTERS
CHILLED IRON SHOT—BLASTYTE
FOUNDRY EQUIPMENT
WE SHOT OR SAND-BLAST FOR ALL TRADES
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for 'longer life' . . . .

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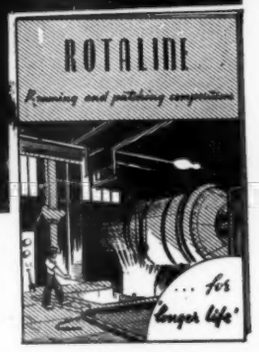

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ROTALINE has a base of high quality calcined silica rock and it is bonded with other suitable refractory materials. The satisfactory results obtained in numerous furnaces throughout the country substantiate the outstanding quality of this material. Rotaline is supplied in a suitable condition for ramming and no mixing or treatment is necessary before use.

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Raw Material Markets

While heavy engineering concerns have been working to capacity for a long time past, light-castings foundries are only just beginning to take a share in the production of defence requirements of the nation. It seems certain that the various Government departments will make increasing use of these works, but short time cannot be avoided as yet. Very little iron or steel is available for ordinary domestic users after the needs of priority consumers have been met. The export trade, however, is being given every possible consideration and an expansion of overseas business is looked for.

Pig-Iron

MIDDLESBROUGH—Ironfounders in this area are turning out large quantities of iron, but most of the production is earmarked for the steelworks and other licensed consumers. Most of the local foundries have secured substantial Government contracts and satisfactory deliveries of iron are arriving from the Midlands to meet the increasing demand. Little attention can be given to the export trade and, in view of the magnitude of future home requirements, prospects of an early change in this position are not encouraging. The Control authorities are chiefly concerned that the best use is made of available supplies and in this respect it would appear that their efforts are quite successful.

Local demands on the resources of the hematite makers are considerable and only a comparatively small proportion of the output can be spared for distribution among users outside of the Cleveland district. Producers are disposing of their whole outputs without delay and stocks are very slender. Most users are securing adequate tonnages to enable them to operate their plants satisfactorily, but it is not always possible to obtain the particular grade to which they have become accustomed, as the special qualities are needed largely for work of national importance.

LANCASHIRE—With certain foundries in possession of additional Government work, the demand for pig-iron tends to increase and is on a very large scale. The quietest section continues to be the light-castings branch, which is still in need of much more work to enable it to operate to capacity. Users generally are acquiring good tonnages of Midlands iron and the delivery position is such that no consumer on the priority list is allowed to go short. There is quite a brisk demand for West Coast qualities of hematite.

MIDLANDS—Owing to the special irons being well accounted for, additional tonnages of high-phosphorus iron are being called for. Many consumers have been compelled to adjust their mixtures to meet the prevailing conditions. Consumption of high-phosphorus iron is still not heavy, as the principal users, the light-castings makers, cannot find sufficient orders to keep their works on full production, but the output has been curtailed for some time past and stocks are now on the low side. The major activities of the ironmakers in this area are confined to the production of material for the steelworks and heavy engineering concerns. The requirements of these consumers are so extensive that the strictest control has to be exercised over distribution.

SCOTLAND—Owing to the heavy consumption of pig-iron, opportunities for stocking are non-existent, so that consumers have to rely upon adequate tonnages coming through to satisfy their current requirements. Fortunately, supplies are coming to hand quite freely, but users would welcome the chance to put a little by as a precaution against possible delays in the winter. Heavy engineering concerns generally are as busy as their productive capacity will allow, but the situation among light-castings makers in the Falkirk district is slow to improve and idle time is reported by many concerns. A small expansion in the number of Government specifications is relieving the position to some extent, but there is urgent need for additional orders to counteract the loss of house-building activities and much of the overseas trade.

Coke

The situation in the foundry coke market is unchanged. The present controlled figure, which is subject to the rise and fall clause, is 55s. 6d., minimum, delivered Birmingham and Black Country stations. There are very few consumers who have not contracted forward for their requirements, and many are taking extra tonnages, which are readily available over and above their current requirements.

Steel

While steelmakers still have their work cut out to meet the insistent demands on the industry, only in comparatively few departments does the demand outstrip the supply to any serious extent, and the majority of users are obtaining sufficient steel to facilitate continuous working. This applies, of course, solely to consumers engaged upon contracts placed by the Government, the position of other users being difficult. With the continued enlargement of the Government defence programme, however, more and more steel consumers are sharing in official work, and of the large peace-time users building contractors appear to be the most severely hit at the present juncture. Control over steel production is almost complete, and the authorities indicate the type of material required of the makers. Holidays, in their true sense, have been cancelled, and the only idle time results from brief periods due to the need for repair work to be carried out.

Scrap

The steel furnaces continue to benefit by large deliveries of scrap, but requirements in this respect are insatiable and all material is promptly absorbed. The Ministry of Supply is now adopting certain measures of compulsion regarding the collection of scrap, but even more vigorous steps will have to be taken if the full benefit is to be derived from the large tonnage of scrap still lying idle at works, farms and in other directions. That full measures of compulsion will have to be used before long is certain and it is in the interest of the nation's war effort that they are introduced at the earliest possible moment. Through the medium of the Scrap Iron and Steel Federation much useful work has been done and allegations that merchants are holding back material would appear to be unfair. They are, in fact, operating on a narrow margin of profit.

Metals

The Non-Ferrous Metals Control has announced that licences for the purchase of copper and zinc will be granted more freely against orders for the export of semi-manufactured and manufactured articles, provided the capacity so used is not required for Government orders. This move will be generally welcomed and certainly is an indication of the satisfactory position of supplies of the metals referred to. Consumption of copper in connection with munitions production has been on a vast scale and will continue to be so in the future. In addition to providing exporters with valuable opportunities to expand their outlets, the foreign exchange acquired will, of course, be an asset to the nation.

The Non-Ferrous Metals Control has requisitioned some 2,000 tons of copper still held on London Metal Exchange warrants in London. Payment will be made at the rate of £54 a ton based on the Exchange's standard contract terms. It is apparently the intention of the authorities to take over the metal declared when the Control recently called for the return of all privately held stocks of copper.

Domestic consumption of copper in the United States tends to increase, as is shown in the returns for June, when consumption was 70,237 short tons, against 67,480 tons in May. The net stocks of fabricators in June were 312,802 tons, compared with 267,922 tons in May, while their unfilled orders were 231,234 (189,637) short tons. During the month of June, however, fabricators' stocks of copper in excess of their unfilled orders rose to 81,568 tons from 78,285 tons at the end of the previous month.

Quite a firm tone has ruled on the London tin market recently, while a moderate amount of business is reported from the other side of the Atlantic. The United States Government is prepared to purchase a further 65,000 tons of tin at the fixed price of 50 cents and this factor is likely to keep quotations steady.

London Metal Exchange tin prices this week have been as follow:—

Cash—Thursday, £266 15s. to £267; Friday, £266 5s. to £266 15s.; Monday, £267 15s. to £268; Tuesday, £268 10s. to £268 15s.; Wednesday, £269 to £269 5s.

Three Months—Thursday, £266 15s. to £267; Friday, £266 to £266 5s.; Monday, £267 to £267 5s.; Tuesday, £268 to £268 5s.; Wednesday, £268 10s. to £268 15s.

For a long time past consumers of spelter for export have not received as much metal as they have desired, but more overseas trade is expected to mature now that some relaxation is to be made in the distribution of zinc.

Non-Ferrous Scrap

The Minister of Supply announced on Tuesday the steps which the Ministry will take to ensure that the best use is made of scrap metal (other than iron and steel).

The Ministry will guarantee to purchase from smelters at a fixed price rough copper and secondary pig-lead reaching certain percentages of purity. With this guaranteed market, smelters will be able to purchase from dealers the lower grades of non-ferrous scrap, which have been tending to accumulate. The Ministry of Supply points out that there has not been any difficulty or hold-up in the case of high-grade brass or copper scrap which finds its way into consumption at works. The difficulty has affected only lower-grade alloys and the step now announced should ensure the interest of the smelting works in these alloys, since they can be sure of disposing of the metal after treatment.

SMALL ADVERTISEMENTS

MACHINERY—*Continued from page 14*

FOR SALE.—One Type B.P.O. No. 209 Pin Lift Jolt Squeeze Moulding Machine with Vibrator; take boxes 16 in. by 20 in. with 8-in. lift.

ONE Mannesman Plate Type as above, take boxes 24 in. by 24 in.—Box 402, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & CO. LTD., Station Works, Ecclesfield, Sheffield.

SELAS TURNER ROTARY FURNACE, 500 lbs. brass capacity (150 lbs. aluminium), gas fired; good condition; new lining. Can be made oil fired.

Heavy-duty Oil and Gas Burners, large and small type.

Particulars:—

LEES HALL,
113, WHITEHOUSE COMMON ROAD,
SUTTON COLDFIELD, WARWICK.
Tel.: Sut. 3749.

MISCELLANEOUS

"A STUDY IN ECONOMY"
ACTUAL MANUFACTURES
BY USING OUR

Foundry Blackings, Facings, Parting Powder, Core Gum, Terra Flake, Talc Coal Dusts, Ganister, Ceylon Plumbago (Imports direct). We definitely help to produce perfect Castings. Only the best minerals used in the making. A trial order will convince users of their economic value.

JOHN & C. DURRANS,
PENNINE WORKS, HAZLEHEAD,
NEAR SHEFFIELD.

Telephone: 128 Penistone
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ALUMINIUM ALLOYS
—to-day and to-morrow

In the unceasing development of Aluminium Alloys you can be sure that from our wealth of scientific experience, every help the foundryman can be given in perfecting casting technique, is given by International Alloys Ltd. Whenever there is a new specification for an Aluminium Alloy you can always rely upon this organisation as your best source of supply.

INTERNATIONAL ALLOYS LTD
SLOUGH, BUCKS

TELEGRAMS: INTALLOYD, SLOUGH ◆ TELEPHONE: SLOUGH 23212

RAW MATERIALS—PRICE LIST

Wednesday, July 31, 1940

COPPER*

	£	s.	d.
Electrolytic	62	0	0
High-grade fire-refined ..	61	10	0
Fire-refined of not less than 99.7 per cent.	61	0	0
Do., do., 99.2 per cent. ..	60	10	0
Black hot-rolled wire rods..	65	10	0

TIN

	£	s.	d.
Standard cash	269	0	0
Three months	269	0	0
Settlement	269	0	0
Official average Cash, June	273	12	10½
Do. Three Months, June	274	9	6
Do. Settlement, June ..	273	12	0

SPELTER*

	£	s.	d.
G.O.B. (foreign) (duty paid)	25	15	0
Do. (domestic)	26	10	0
" Prime Western " ..	26	10	0
Refined and electrolytic ..	27	5	0
Not less than 99.99 per cent.	28	15	0

LEAD*

	£	s.	d.
Good soft pig lead (foreign) (duty paid)	25	0	0
Do., do., (Empire and domestic)	25	0	0
English	26	10	0
Sheets, home	34	10	0
Do. export, f.o.b. ..	30	0	0
Pipes, home	34	0	0
Do. export, f.o.b. ..	30	10	0
Tea lead (nom.)		—	

ALUMINIUM

Ingots	£110
Wire, 10g.	nom.
Sheets	nom.
Circles, 20/24g.	nom.

ZINC SHEETS, etc.

	£	s.	d.
Sheets, 10g. and thicker, ex works	39	2	6
Rolled zinc (boiler plates), ex works	37	2	6
Zinc oxide (Red Seal), d/d buyers' premises ..	28	7	6

ANTIMONY

	£	s.	d.
English, 99%	98	10	0
Foreign Regulus, duty paid	99	0	0
Chinese, prompt shipment, c.i.f. ..	82 0 0 to 84	0	0

QUICKSILVER

Quicksilver, ex-w'hse London 57 0 0 to 60 0 0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 0d.
Finished bars, 18% tungsten	3s. 10d.
Finished bars, 22% tungsten	4s. 4d.

Per lb. d/d buyers' works.

NICKEL SILVER, etc.

	Per lb.
Ingots for raising ..	9d. to 1/3
Rolled—	
To 9 in. wide ..	1/3 to 1/9
To 12 in. wide ..	1/3½ to 1/9½
To 15 in. wide ..	1/3½ to 1/9½
To 18 in. wide ..	1/4 to 1/10
To 21 in. wide ..	1/4½ to 1/10½
To 25 in. wide ..	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
to 10g.	1/6½ to 2/1½

with extras according to gauge.

Special 5ths quality turning rods in straight lengths, 1/5½ upwards.

* Maximum prices per long ton delivered to buyers' premises.

FERRO-ALLOYS AND STEEL-MAKING METALS

(all prices nominal)

	£	s.	d.
Ferro-silicon—			
25%	18	10	0
45/50%	21	10	0
75%	31	0	0
Ferro-vanadium—			
35/50%	15/6 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free ..	6/- lb. Mo.		
Ferro-titanium—			
20/25% carbon-free ..	1/9 lb.		
Ferro-tungsten—			
80/85%	5/1 lb.		
Tungsten metal powder—			
98/99%	5/2½ lb.		
Ferro-chrome—			
2/4% car.	—		
4/6% car.	47	0	0
6/8% car.	47	0	0
8/10% car.	—		
Ferro-chrome—			
Max. 2% car.	—		
Max. 1% car.	—		
Max. 0.5% car. ..	—		
70% carbon-free ..	—		
Nickel—99.5/100%	..£190 to £195		
" F " nickel shot	175	0	0
Ferro-cobalt, 98/99% ..	8/9 lb.		
Metallic chromium—			
96/98%	3/9 lb.		
Ferro-manganese—			
76/80% loose	18	0	0
76/80% packed	19	10	0
Metallic manganese—			
94/96% carbon-free ..	1/9 lb.		

Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.

SCRAP*

	£	s.	d.	£	s.	d.
SOUTH WALES—						
Short heavy steel, not ex. 24-in. lengths.. ..	3	16	6	to 3	19	0
Heavy machinery cast iron		4	6	6		
Ordinary heavy cast iron		4	1	6		
Cast-iron railway chairs		4	6	6		
Medium cast iron ..		3	17	9		
Light cast iron		3	13	0		
MIDDLESBROUGH—						
Short heavy steel	3	14	3	to 3	16	9
Heavy machinery cast iron		4	11	3		
Ordinary heavy cast iron		4	8	9		
Cast-iron railway chairs		4	8	9		
Medium cast iron ..		3	19	0		
Light cast iron		3	14	0		
BIRMINGHAM DISTRICT—						
Short heavy steel	3	9	3	to 3	11	9
Hematite ingot mould		5	10	9		
Heavy machinery cast iron		4	11	9		
Ordinary heavy cast iron		4	7	0		
Cast-iron railway chairs		4	7	0		
Medium cast iron ..		3	19	9		
Light cast iron		3	14	9		
SCOTLAND—						
Short heavy steel	3	14	0	to 3	16	6
Heavy machinery cast iron		4	13	9		
Ordinary heavy cast iron		4	8	9		
Cast-iron railway chairs		4	13	9		
Medium cast iron ..		3	16	9		
Light cast iron		3	11	9		

* Delivered free to consumers' works in England and Wales. For deliveries of cast-iron scrap free to consumers' works in Scotland, the above prices less 3s. per ton, but plus actual cost of transport or 6s. per ton, whichever is the less. All prices: Plus 2½ per cent. dealers' remuneration: 50 tons and upwards over three months 2s. 6d. extra.

PIG-IRON*

	£	s.	d.
N.E. COAST (d/d Tees-side area)—			
Foundry No. 1	123/-		
" No. 3	120/-		
" No. 4	119/-		
Forge No. 4	119/-		
Hematite No. 1	131/-		
Hematite M/Nos.	130/6		
N.W. COAST—			
Hem. M/Nos. d/d Glas. ..	131/-		
" d/d Birm.	142/6		
MIDLANDS (d/d Birmingham dist.)—			
Staffs No. 4 forge	121/-		
" No. 3 fdry.	122/-		
Northants forge	118/6		
" fdry. No. 3 ..	119/6		
" fdry. No. 1 ..	122/6		
Derbyshire forge	121/-		
" fdry. No. 3 ..	122/-		
" fdry. No. 1 ..	125/-		
Phosphorus 0.5% to 0.75%	129/6		
Phosphorus 0.1% to 0.5%	132/6		
SCOTLAND—			
Foundry No. 1, Grangemouth	119/9		
" No. 3, Grangemouth	117/3		
Cleveland No. 3, Glasgow	123/-		
" " Falkirk ..	120/-		
Scottish hem. M/Nos. d/d..	131/-		
SHEFFIELD (d/d district)—			
Derby forge	118/6		
" fdry. No. 3 ..	119/6		
Lincs forge	118/6		
" fdry. No. 3 ..	119/6		
W.C. hematite	136/6		
LANCASHIRE (d/d eq. Man.)—			
Derby fdry. No. 3 ..	125/-		
Staffs fdry. No. 3	125/-		
Northants fdry. No. 3 ..	123/6		
Cleveland fdry. No. 3 ..	125/-		
Cylinder and Refined Irons			
North Zone..	168/-		
South Zone..	170/6		
Refined Malleable			
Birmingham and S. Staffs ..	165/6		
Cold Blast			
South Staffs	217/-		

* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.

	£	s.	d.
BASIC:			
Soft, u.t., 100-ton lots ..	10	10	0
Tested, up to 0.25% C. ..	10	15	0
Tested, 0.25 to 0.33% C.	10	17	6
Tested, 0.33 to 0.41% C...	11	0	0
Hard (0.42 to 0.60% C.)..	11	17	6
" (0.61 to 0.85% C.)..	12	7	6
" (0.86 to 0.99% C.)..	12	17	6
" (1% C. and up) ..	13	7	6
Silico-manganese	14	5	0
Free-cutting	12	10	0
SIEMENS MARTIN ACID			
Up to 0.25% C.	13	15	0
Case-hardening	14	12	6
Silico-manganese	14	10	0

Billets, Blooms and Slabs for Forging and Stamping.

Basic soft, up to 0.25% C. ..	12	2	6
Basic hard, 0.41 to 0.60% C.	12	10	0
Acid, up to 0.25% C. ..	14	5	0

Other Semi-products, etc.

Tin bars	10	7	6
Sheet bars	10	7	6
*Wire rods, soft basic ..	15	4	0
" hard basic ..	18	12	6
" free-cutting ..	17	12	6
" acid	22	3	6

* Subject to rebate.

FINISHED STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel bars, sections plates joists and hoops is obtainable in the home trade under certain conditions.]

	£	s.	d.
Plates, ship (N.E. Coast) ..	14	3	0
Boiler plts. (N.E. Coast) ..	15	0	6
Chequer plts. (N.E. Coast)	15	13	0
Angles, over 4 un. ins. ..	13	13	0
Tees, over 4 un. ins. ..	14	13	0
Joists, 3 in. × 3 in. and up	13	13	0
Rounds and squares, 3 in. to 5½ in.	14	13	0
Rounds under 3 in. to ⅜ in. (untested)	15	8	6
Flats—over 5 in. wide ..	13	18	0
" 5 in. wide and under ..	15	8	6
Rails, heavy, f.o.t. ..	12	15	6
Hoops	16	3	6
Black sheets, 24 g. (4 t. lots)	19	7	6
Galv. cor. shts. (")	22	12	6
Galv. flat shts. (")	23	2	6
Galv. fencing wire, 8g. plain	24	7	6

FINISHED IRON

	£	s.	d.
CROWN IRON:			
England and Wales ..	15	2	6
Scotland	15	2	6
Ireland, f.o.q.	15	15	0
No. 3 BARS:			
England and Wales ..	12	5	0
Scotland	13	7	6
Ireland, f.o.q.	12	17	6
No. 4 BARS:			
England and Wales ..	12	15	0
Scotland	13	12	6
Ireland, f.o.q.	13	7	6
STRIP:			
England and Wales ..	16	10	0
STAFFS MARKED BARS, f.o.t...	18	0	0

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated, July 11, 1940.

	Dols.
No. 2 foundry, Phila.	24.84
No. 2 foundry, Valley	23.00
No. 2 foundry, Birm.	19.38
Basic, Valley	22.50
Malleable, Valley..	23.00
Grey forge, Valley	22.50
Ferro-mang., seaboard	120.00
O.-h. rails, h'y, at mill	40.00
Billets	34.00
Sheet bars	34.00
Wire rods	2.00
	Cents.
Iron bars, Chicago	2.25
Steel bars	2.15
Tank, plates	2.10
Beams, etc.	2.10
Skelp, grooved steel	1.90
Steel strip	2.10
Steel sheets	2.10
Sheets, galv., No. 24	3.50
Wire nails	2.55
Plain wire	2.60
Tinplates, 100-lb. box	$5.00

COKE (at ovens)

Welsh foundry	42/6 to 44/-
" furnace	31/6 to 33/-
Durham foundry	39/6
" furnace	33/5
Scottish foundry	42/6 to 47/6
" furnace	31/6

TINPLATES

f.o.b. Bristol Channel ports

I.C. cokes	20 × 14 per box	27/6 to 28/-	
"	28 × 20 "	55/- to 56/-	
"	20 × 10 "	40/- to 42/-	
"	18¾ × 14 "	..	30/-
C.W.	20 × 14 "	..	27/6
"	28 × 20 "	..	55/-
"	20 × 10 "	..	40/-
"	18¾ × 14 "	..	29/-

NON-FERROUS SCRAP

(Official Maximum Prices, per ton ex Works.)

	£	s.	d.
Bright untinned copper wire, in crucible form or in hanks	57	10	0
No. 1 copper wire	57	0	0
No. 2 copper wire	55	10	0
Copper firebox plates, cut up	57	10	0
Clear untinned copper, cut up	56	10	0
Braziery copper	53	10	0
Q.F. process and shell-case brass, 70/30 quality, free from primers	49	0	0
Clean fired 303 S.A. cartridge cases	47	0	0
70/30 turnings, clean and baled	43	0	0
Brass swarf, clean, free from iron and commercially dry	34	10	0
New brass rod ends, 60/40 quality	38	10	0
Hot stampings and fuse metal, 60/40 quality	38	10	0
Admiralty gunmetal, 88-10-2, containing not more than ¼ per cent. lead or 3 per cent. zinc, or less than 9½ per cent. tin	72	0	0

NEW BRASS TUBES, etc.

	Per lb.
Solid drawn tubes	13½d.
Brazed tubes	15½d.
Rods, drawn	11½d.
Rods, extd. or rlld.	8½d.
Sheets to 10 w.g.	10½d.
Wire	10½d.
Rolled metal	9½d.
Yellow metal rods	8½d.

COPPER TUBES, etc.

Solid drawn tubes	14½d.
Brazed tubes	14½d.
Wire	9½d.

PHOSPHOR BRONZE

	Per lb. basis
Strip	13½d.
Sheet to 10 w.g.	13½d.
Wire	15½d.
Rods	15½d.
Tubes	20½d.
Castings	17d.

Delivery 3 cwt. free.
10% phos. cop. £35 above B.S.
15% phos. cop. £40 above B.S.
Phosphor tin (5%) £40 above price of English ingots.
C. Clifford & Son, Limited.

A COMPARISON OF SCRAP PRICES

Average Delivered Prices of Heavy Steel Scrap (large quantities) in the Principal Districts at the Beginning of Each Month in the Years 1933–1940.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Scotland—													
1933	1 15 0	1 17 6	1 18 6	1 18 9	1 18 0	1 17 6	1 18 9	2 0 0	2 2 6	2 5 0	2 7 6	1 15 0	1 16 9½
1934	2 8 9	2 14 3	2 13 0	2 13 0	2 12 0	2 10 0	2 10 6	2 10 6	2 11 0	2 10 9	2 10 0	2 8 9	2 0 7½
1935	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 10 0	2 11 2
1936	2 12 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 1
1937	2 17 6	3 2 6	3 6 0	3 5 9	3 5 9	3 5 9	3 5 9	3 5 9	3 5 9	3 5 9	3 6 3	3 6 3	3 4 9½
1938	3 6 3	3 6 3	3 6 3	3 6 3	3 6 3	3 6 3	3 6 3	3 6 3	3 6 3	3 6 3	3 6 3	3 6 3	3 6 3
1939	2 17 9	2 17 9	2 17 9	2 17 9	2 17 9	2 17 9	2 17 9	2 17 9	2 17 9	2 19 0	2 19 0	2 19 0	2 18 0½
1940	2 19 0	2 19 0	3 9 0	3 9 0	3 9 0	3 9 9	3 9 9	—	—	—	—	—	—
North-East Coast—													
1933	2 0 0	2 0 0	2 5 0	2 0 0	1 15 0	1 17 6	2 2 6	2 2 6	2 3 6	2 5 0	2 7 6	2 7 6	2 2 2
1934	2 10 0	2 16 0	2 10 0	2 7 6	2 7 6	2 10 0	2 9 9	2 10 0	2 10 0	2 10 0	2 11 6	2 11 3	2 10 3½
1935	2 11 6	2 11 9	2 12 0	2 12 0	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 12 6	2 13 9	2 12 4½
1936	2 15 0	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	3 0 0	3 0 0	2 17 8½
1937	3 2 6	3 5 0	3 7 0	3 7 9	3 7 9	3 7 9	3 7 9	3 7 9	3 7 9	3 7 9	3 8 3	3 8 3	3 7 1½
1938	3 8 3	3 8 3	3 8 3	3 8 3	3 8 3	3 8 3	3 8 3	3 8 3	3 8 3	3 8 3	3 8 3	3 8 3	3 8 3
1939	2 19 9	2 19 9	2 19 9	2 19 9	2 19 9	2 19 9	2 19 9	2 19 9	2 19 9	3 1 0	3 1 0	3 1 0	3 0 0½
1940	3 1 0	3 1 0	3 11 0	3 11 0	3 11 0	3 11 9	3 11 9	—	—	—	—	—	—
South Wales—													
1933	2 0 0	2 1 6	2 4 0	2 3 6	2 3 6	2 3 0	2 5 0	2 5 0	2 8 0	2 10 0	2 10 0	2 10 0	2 5 3½
1934	2 10 0	2 16 3	2 15 9	2 13 9	2 14 3	2 15 0	2 14 3	2 14 3	2 15 0	2 15 6	2 15 6	2 15 6	2 14 7
1935	2 15 6	2 15 6	2 15 6	2 15 6	2 15 6	2 15 6	2 15 6	2 15 6	2 16 1½	2 17 9	2 19 8	3 1 1½	2 16 2½
1936	3 2 6	3 5 0	3 5 0	3 5 0	3 5 0	3 5 0	3 3 0	3 2 0	3 2 0	3 4 0	3 4 0	3 4 0	3 3 10½
1937	3 5 0	3 10 0	3 10 0	3 8 9	3 8 9	3 8 9	3 8 9	3 8 9	3 9 9	3 9 9	3 9 9	3 9 9	3 14 7½
1938	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0	3 10 0
1939	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6	3 1 6
1940	3 1 6	3 1 6	3 11 6	3 11 6	3 11 6	3 12 6	3 12 6	—	—	—	—	—	—

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SITUATIONS VACANT AND WANTED

FOUNDRY changing to Steel Converter production require skilled help: Foundry Manager; Converter Blower; Core Shop Foreman. Give experience and salary required to:—Box 406, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

FOUNDRY CORE SHOP CHARGEHAND required. About 30 miles north of London. Female Operators employed, handling repetition small oil sand cores. Apply, stating age, details of past experience and wage required, to:—BAGSHAWE & COMPANY, LIMITED, Dunstable.

FOUNDRY FOREMAN or MANAGER required in the South Yorkshire District. Essential qualifications: Strict disciplinarian, resourceful, tactful, able to produce modern engineering castings (iron), and a good organiser. Reply, giving full particulars and experience, to:—Box 404, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

FOUNDRY MANAGER with highly successful record in Foundry Management seeks contact with Firm desiring first-class man. Expert on Modern Foundry Methods, including Mixing of High-Duty and Alloy Cast Irons to close specifications. Familiar with progressive methods of foundry production, Hand and Power machine production, and mechanisation for General Foundry. Can assure economical production of quality castings to 20 tons weight. Accurate estimates given from drawings; knowledge of foundry costing, and accustomed to absolute control of foundries and patternshop. Have been successful in introducing new business. Discipline and labour control assured. Experience of Bonus and Piecework systems.—Box 394, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

FOUNDRY SUPERINTENDENT, with thorough knowledge of a modern non-ferrous foundry organisation and production methods—good disciplinarian—required for permanent position:—Box 390, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

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WANTED.—Well-connected Gentlemen calling on foundries in all districts except Central Midlands, to introduce a new grade of Non-Silica Parting Powder, also Foundry Riddles and Sieves, on commission basis.—Box 392, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

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Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

FOUNDRY MANAGER requires re-engagement, iron, non-ferrous, green-sand, dry-sand, loam moulding. Accustomed latest methods, wide experience over 30 years, general engineering castings. (385)

SITUATIONS VACANT AND WANTED—*Contd*

ASSISTANT FOUNDRY MANAGER required. Must have some engineering experience as well as knowledge of metals. Write, stating age and wages required, to:—JAMES & COMPANY (BIRMINGHAM), LIMITED, Manor Lane, Halesowen.

FOUNDRY FOREMAN.—Grey Iron Castings, and preferably also with experience of Malleable Iron Castings, for old-established Iron Foundry near Bilston, Staffs, now fully engaged on important Government Contracts. Must be a really capable man and a good disciplinarian. Please write giving fullest particulars and state salary required to:—Box 400, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

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WANTED.—Bonvillain and Ronceray Pan Mill with Plain Rollers. State full particulars to:—Box 396, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

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Macdonáld Jolter, table 72 in. by 54 in.
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PLAIN JOLT RAM, with table 54 ins. square, cyl. 12 ins. dia. £90.

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